

Oil Spill Response Atlas for the Southwest Coast of Vancouver Island

Cover Photo

by Dore Nunn/Vicpoints West
Surf and mist, West Coast Trail,
Vancouver Island.

OIL SPILL RESPONSE ATLAS FOR THE SOUTHWEST COAST OF VANCOUVER ISLAND

by
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for
Environmental Emergencies & Coastal Protection Branch
BC Environment
Province of British Columbia
The Honourable John Reynolds, Minister

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Errata

"Oil Spill Response Atlas for the Southwest Coast of Vancouver Island"

Page ii

Cheif Councillor Pat Chips of Beecher Bay is missing from the Acknowledgements

Page 1-4

The User Guide Legend for Shoreline Sensitivity is missing the icon for Many Birds.

This symbol indicates higher concentrations of marine birds relative to the remaining study area.

Page 3-3

The Shoreline Sensitivity Legend is missing the icon for Many Birds. The Environmental Description for the Many Birds Symbol for Areas 1 and 3 on the Operational Map 1 are:

B1 Birds congregate around Race Rocks due to good foraging opportunities (birds: cormorants and diving ducks)

B3 Beecher Bay is a shelter for wintering birds

Pages 3-9, 3-79 and 3-85

The Shoreline Sensitivity Legends for these Operational Maps are missing the icon for Intertidal Harvesting (SH). These sites, however, are described in the Environmental Description.

Page 3-99

Tsusiat River is incorrectly spelled in the title of this page.

Page 3-103

The Shoreline Sensitivity Legend is missing the icon for Many Birds. The Environmental Description for the Many Birds Symbol for Area 57 on the Operational Map 18 is:

B 57 Birds congregate around Seabird Rocks due to good foraging opportunities (birds: cormorants and diving ducks); see **BC57**

Page A-34, Figure A7

The high and low ranking labels on the graph are misplaced. High should be where low is located and vice versa.



PREFACE

This oil spill response atlas was prepared for the British Columbia Ministry of Environment by DF Dickins Associates Ltd. to provide a synthesis of environmental information relevant to the planning and implementation of oil spill countermeasures along the southwest coast of Vancouver Island. The atlas serves as a planning document during an emergency situation.

Study Team

Individual responsibilities and contributions to the atlas are outlined below:

David Dickins of DF Dickins Associates Ltd. directed the project together with study team managers in the different scientific areas. Aileen Cassidy of DF Dickins Associates Ltd. established graphics standards, text layouts, and managed production of the camera-ready copy.

Ingrid Bjerkelund and Martin Poulin of DF Dickins Associates Ltd. coordinated input to the maps and text, developed the sensitivity ranking for human use and special status areas, and combined the individual elements in the different categories to arrive at the overall ranking. Kim Murphy-Jung assisted with the desktop publishing.

Martin Poulin prepared the maps and produced the computer files for the camera-ready copy.

Ann Godon of DF Dickins Associates Ltd. prepared the information on oceanography and climate.

Harriet Rueggeberg and Jackie Booth of Hammond Bay Environmental Services compiled information on the biological resources, and refined and applied the biological sensitivity rankings. Harriet Rueggeberg participated in a field survey to evaluate the relevance of different cleanup techniques.

John Harper of Harper Environmental Services developed and applied the shoreline sensitivities from estimates of relative shore zone oil residence times. He participated in a field survey to evaluate the relevance of different cleanup techniques.

Laurie Solsberg of Counterspill Research Inc. developed the shore access and countermeasures information. He also organized a field survey to evaluate the relevance of different cleanup techniques.

James Haggarty of Shoreline Archaeological Services Inc. and Kevin Neary documented the archaeological sites and subsistence harvesting, and developed the sensitivity ranking system for those elements from information acquired during visits to the Indian bands. Kevin Neary also provided information on the native communities.

Doug Reimer of EML Environmental Mapping conducted the initial cataloguing of shoreline types.

Funding Agency

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Scientific Authority and Contract Manager

D.E. Howes Environmental Emergencies and Coastal Protection Branch
B.C. Ministry of Environment

ACKNOWLEDGEMENTS

British Columbia Ministry of Environment

The British Columbia Ministry of Environment gratefully acknowledges and appreciates the cooperation and information provided by the following native communities: Beecher Bay Band, Ditidaht Indian Band, Ohiaht Band Council, Sooke Indian Band, and Pachenaht Band.

The atlas greatly benefited from several critical reviews by M. Dunn of Environment Canada. In addition, the following individuals provided critical review and constructive comments on various segments of the atlas: C.P. Lewis and B. Holden of B.C. Ministry of Environment (physical shoreline); M. Wayne, B. Munro, G. Chislett, D. Hadley, and S. Reid of the B.C. Ministry of Environment and P. Kaiser of Environment Canada (biological resources); R. Inglis and G. Keddie of the B.C. Royal Museum (heritage resources); F. Beech of Environment Canada (countermeasures).

Study Team

The study team gratefully acknowledges the following individuals and agencies for their contributions to the atlas:

J. McMurdo and J. Foster of the Archaeology and Outdoor Recreation Branch, Province of British Columbia for archaeological information

M. Foreman of the Institute of Ocean Sciences for providing data on tidal currents and for reviewing the tidal and residual current section

Chief Councillors Spencer Peters, Jackie Thompson, Ken Jones, and Larry Underwood, of the Beecher Bay, Ditidaht, Ohiaht, Pachenaht, and Sooke Indian bands for their involvement and contributions to the subsistence harvesting, and Chief Art Peters for his advice and assistance

The study team thanks the many individuals who supplied unpublished information, in many cases from their own personal knowledge. These individuals are listed under the Personal Communication heading in the Bibliography section.

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1.0 INTRODUCTION

1.1 Objectives

The overall objective of the atlas is to provide a synthesis of environmental information relevant to the planning and implementation of oil spill countermeasures in the coastal area of southwest Vancouver Island.

The atlas is designed to link the environmental characteristics and resources of the region to practical considerations of oil spill response. This linkage is achieved through a ranking system which numerically describes the relative sensitivity of different coastal areas to the effects of a marine oil spill. The ranking system allows users to assign priorities to specific areas requiring protection and/or immediate cleanup.

The atlas can be used on site in the event of a spill, in an oil spill planning and training situation, and as an overall environmental atlas of coastal resources.

1.2 Background

This atlas is modelled on the *Environmental Atlas for Beaufort Sea Oil Spill Response* completed for Environment Canada (Dickins et al., 1987). Significant changes were made to the sensitivity ranking system to account for the unique physical, biological, and cultural features of the southwest coast of Vancouver Island. For example, heritage resources, commercial fisheries, tourist industries, and recreational use assumed much greater or entirely new roles within a modified and expanded ranking system (see Appendix A for a detailed description).

It is intended that this volume be the first in a series of atlases covering the British Columbia coast.

The maps printed in this atlas exist as computer files within a Geographic Information System. Future versions of the atlas could be developed to be fully interactive on the computer.

The study area covers the southwest coast of Vancouver Island from Christopher Point (Race Rocks) to Cape Beale. Four communities are located within this area: Sooke, Port Renfrew, Jordan River, and Anacla-

The atlas area incorporates the Pacific Rim National Park and the well-known West Coast Trail.

The information shown in the atlas is generally restricted to those activities and resources which would be impacted in the event of a marine oil spill, that is located in the near shore area within 2 km of the coast or inside of the extreme high tide line. Exceptions include tourist accommodations, industries, and heritage sites which could be adversely affected by long-term damage tied to the oil itself or the cleanup operations.

In terms of oil spill response, the coast in this area is generally rugged and difficult to reach by land or sea. There are no airstrips and helicopter operations are often restricted to low tide when the rock platforms are exposed along much of the shore. The local Indian bands provide a valuable source of local knowledge in the area.

1.3 Contents and Organization

The operational information in the atlas is presented at a scale of 1:40,000 (digitized from the NTS 1:50,000 map sheets).

The following titles highlight the maps and information contained within the atlas.

SUMMARY MAPS ~1:330,000

Overview of Sensitivity Areas

OPERATIONAL MAPS ~1:40,000

Shoreline Sensitivity

- biological resources
- offshore harvesting
- intertidal harvesting
- tourism
- recreation
- industries
- commercial fisheries
- communities

- heritage sites
- durations of biological activity and resources use
- environmental descriptions

Physical Environment and Countermeasures

- shoreline morphology
- shore access
- anchorages
- helipads and landing sites
- description of possible countermeasures
- description of access limitations

APPENDICES

Sensitivity Ranking System

Climate and Oceanography

1.4 Sensitivity Ranking

The sensitivity ranking system used in the atlas describes the relative sensitivity of the shoreline to potential impact from a marine oil spill. The sensitivity ranking system is based on a scheme developed for the *Environmental Atlas for Beauport Sea Oil Spill Response* (Dickins et al., 1987) with significant modifications to account for the important cultural, biological, and human resources along the southwest coast of Vancouver Island (see Appendix A for a detailed description of the methods used to develop a ranking system which is tailored to the Vancouver Island environment).

The sensitivity ranking system incorporates biophysical and social elements that are important from an oil spill response perspective. The components were ranked within four major sensitivity categories: human use, biological resources, shore zone oil residence, and special status areas (parks, Indian reserves, heritage sites).

The human use category includes communities, native subsistence harvesting, commercial fisheries, tourist industries (e.g., marinas, tourist

lodges, boat charters), recreation (e.g., hiking, kayaking, diving), and commercial industries (e.g., fish processing, log sorting).

Native use of marine and shoreline resources was identified early in the project as a major information gap. Subsequently, the extent of subsistence harvesting was surveyed by visiting five Indian bands in the area. The sensitivity ranking system (see Appendix A, Section 2.1) incorporates this information which is also presented pictorially on the operational maps.

The biological resource category was developed specifically for the study area by accounting for all of the major resources occurring within the region, their vulnerability and long-term sensitivity to oil spills, and their abundance, distribution and seasonal occurrence.

The shore zone oil residence index combines the factors of wave exposure, substrate type, coastal processes, and coastal morphology to arrive at a ranking of relative oil residence times (days to years) for the different areas.

Special status areas include parks, Indian reserves, and heritage sites. A new three-tiered ranking system for heritage sites was developed for this atlas based on the B.C. Archaeological Site Inventory.

The study area was divided into 63 areas for the application of the sensitivity ranking system to determine the final sensitivity ranking. Each shoreline area extends approximately 2 km offshore and extends backshore to include the maximum tidal range.

The relative sensitivity of each shoreline and offshore area is represented by a single number that is calculated by weighing all the important environmental and social components of the region. This numerical value, ranked as extreme, high, moderate, or low, is shown as a coloured band on the sensitivity maps (see User's Guide).

The final sensitivity rankings are intended to provide an on-scene commander and others in charge of responding to an oil spill with a system that ranks areas for protection and cleanup. The rankings will also assist decision making for oil spill response planning and training.

Real-time or contingency planning decisions will need to consider the sensitivity of each shoreline and offshore area on three levels.

First: The broad ranking category (e.g., moderate) provides an immediate appraisal of the relative sensitivity.

Second: The elements which combine to make up the numerical sensitivity value provide planners, local people, and cleanup crews with a clear picture of the important issues in a particular area (e.g., shellfish harvesting, tourist industries). This information is needed to decide on the most appropriate cleanup technique to minimize local impact. The elements that contribute to the sensitivity values for each area are described in the facing pages to the sensitivity maps. The numerical breakdown by category for each area is tabulated as table A19 in Appendix A.

Third: The timing of activities or use of the area by different species allows an immediate assessment of whether the sensitivity ranking applies (in whole or in part) to a particular spill. For example, if moulting birds are an important contributing sensitivity element, but the spill occurs when the moulting birds are not present, then the sensitivity (and priority) of that area may be significantly reduced.

1.5 Countermeasures

The text accompanying the physical maps describes the options for access to specific shoreline areas, and outlines possible cleanup techniques which would have the highest chance of success in different areas (taking into account the substrate, and coastal morphology).

Much of the shoreline covered by this atlas is extremely rugged with high wave exposure, limited marine access, and often dangerous working conditions dependent on the state of the tide and the sea (54% of the coastal length is comprised of cliffs with and without platforms and beaches).

The countermeasures sections of this atlas are not intended as a manual of shoreline cleanup, but rather offer reasonable suggestions for what may be possible. The actual choice of cleanup technique at the time will

depend on site surveys, weather conditions, and equipment availability (e.g., helicopters).

A number of generalizations can be made about the makeup of likely cleanup operations in the area covered by this atlas.

- Most operations will use small crews working with helicopter support where possible (except in the vicinity of Sooke and Port Renfrew, there is an almost complete lack of shoreline infrastructure to support a large-scale cleanup; the rough sea states and lack of reliable anchorages prevent the use of an extensive marine fleet for accommodation and storage).
- The most effective large-scale cleanup operation will focus on areas where some form of water flushing technique has a reasonable chance of success (the alternative of removing all oiled material may not be practical in terms of volume and weight, or in terms of environmental impact).
- Sensitive pocket beach areas will require intensive manual cleanup with removal of oiled debris by helicopter in many locations.
- Bioremediation requires serious consideration as a potential polishing technique to complete or enhance the cleanup.
- The opportunities for effective use of booms and skimmers for oil recovery from the water are limited to a small number of protected areas.

The shoreline character and exposure to the open ocean severely limit the options available for countermeasures. At the same time, these natural characteristics act to reduce the oil residence time and increase the rate at which the oil is naturally dispersed, or removed from the environment.

USER'S GUIDE

Shoreline Sensitivity

Legend

- Shoreline Sensitivity***
- Extreme Sensitivity Ranking > 120
 - High Sensitivity Ranking 100-120
 - Moderate Sensitivity Ranking 70-99.9
 - Low Sensitivity Ranking < 70

* See Appendix A
See Regional Maps for Offshore Sensitivity

Area

No.	Name	Sensitivity Ranking
1	Race Rocks	27.3
2	Christopher Pt.-Smythe Head	26.5
3	NE Becher Bay	46.2
4	W Becher Bay	37.5

	Community		Sea Lion SL
	Aquaculture A		Harbour HS
	Commercial Fisheries CF		Orca Or
	Tourism T		Grey Whale CW
	Industry I		Salmonid Spawning Sa
	Recreation Local RL		Shellfish Sh
	Recreation Diffuse RD		Kelp Beds K
	Intertidal Harvesting SH		Heritage Site High H
	Offshore Harvesting SH		Heritage Site Moderate H
	Bird Colony BC		

Shoreline Sensitivity

The southwest coast of Vancouver Island is divided into 63 shoreline sensitivity areas which are shown on the operational maps. Each shoreline area extends approximately 2 km offshore and extends backshore to include the maximum tidal range (exceptions are made in the case of specific heritage sites, tourist accommodations, and industries which could be adversely affected by either the presence of oil stranded on shore or the cleanup activities).

Summary Maps 1 and 2 highlight the extreme and high sensitivity areas which occur within the atlas boundaries (Race Rocks to Cape Beale).

The relative sensitivity rankings (Extreme, High, Moderate, Low) are shown on the operational maps as coloured bands along the shore. In addition, the legend block displays the numeric sensitivity values for each of the areas contained within a map.

Appendix A provides the background information and detailed rankings necessary to interpret the sensitivity values for each area. Users are encouraged to read this material and familiarize themselves with the manner in which the sensitivities were derived.

Symbols

Each symbol in the legend has an associated code (one or two letters) which is keyed to the accompanying text. For example, RL 2 refers to localized recreation in sensitivity area 2. HS 3 refers to harbour seals occurring in area 3, and so on).

The seasonal durations of biological activity and resource use are shown on the monthly bar plot. Note: only those activities which have a seasonal

pattern are plotted. Most other resources or activities can be assumed to occur year-round.

A number of year-round activities peak during particular months; in these cases, the period of most intense use is plotted (e.g., recreational fishing where most of the year is characterized by low use with low-value fish - in this case the summer months with salmon fishing are highlighted on the plot). Commercial fisheries may be year-round for some species, with specific seasons for others; the specific seasons are highlighted here.

Symbols requiring further explanation are highlighted below:

Commercial Fisheries (CF) includes general estimates of the approximate number of boats operating in the nearshore areas (from personal communication).

Shellfish (Sh) symbols show general locations only. The exact sites of shellfish harvesting are maintained as confidential files. In the event of an oil spill emergency, response personnel must contact the Department of Fisheries and Oceans, South Coast Division for information about specific areas.

Tourism (T) includes accommodation (e.g., lodges, bed and breakfast, motels), sightseeing tours, trailer parks, and marinas. Sports fishing locations are covered under recreation. Tourism peaks in the months of June, July, August, and September.

Recreation Local (RL) includes activities which are identified with a particular location (beaches, campsites, sports fishing, scuba diving, wildlife viewing, surfing). Recreational activities are generally concentrated in the period from May to October.

Recreation Diffuse (RD) includes activities which occur over a broad area such as hiking, kayaking, and sailing.

Heritage Sites (H) are shown as large symbols which intentionally obscure the exact site locations (protected by the Heritage Conservation Act of B.C.). In the event of an oil spill, contact the B.C. Ministry of Environment, Environmental Emergency and Coastal Protection Branch, or the B.C. Ministry of Municipal Affairs, Recreation and Culture, Heritage Conservation Branch in Victoria.

Note: The cumulative sensitivity of a particular area in terms of its heritage resources is described as extremely sensitive, highly sensitive, and sensitive (no relation to the overall sensitivity ranking shown in the coloured bands).

Intertidal Harvesting (SH) and *Offshore Harvesting (SH)* indicate general areas where subsistence harvesting takes place. Offshore subsistence fisheries are only mapped if fishing occurs routinely within approximately 2 km of shore.

The exact number of sites, locations, and species harvested are confidential to individual Indian bands. In an oil spill emergency, detailed information regarding native subsistence harvesting locations can be obtained from the following chief councillors:

Indian Band Chief Councillors

Jackie Thompson
Chief Councillor
Ditidaht Indian Band
Box 340
Port Alberni, B.C.
V9Y 7M8
Campbell River Radiophone N692932
Spencer Peters
Chief Councillor
Ohiatch Band Council
Box 70
Bamfield B.C.
V0R 1B0
728-3414

Larry Underwood
Chief Councillor
Sooke Indian Band
3 Lazzar Rd.
Sooke, B.C.
V0S 1N0
642-3957
Ken Jones
Chief Councillor
Pacheenaht Indian Band
General Delivery
Port Renfrew, B.C.
V0S 1K0
647-5521

Pat Chips
Chief Councillor
Beecher Bay Band
3843 East Sooke Rd.
Box 4, RR 1
Sooke B.C.
V0S 1N0
478-3535

Legend

Coastal Type Descriptions

The following descriptions cover the nine coastal types found within the atlas study area (Section 2.3 in Appendix A describes the different factors affecting oil residence in different areas):

Cliff - rock substrate with narrow (<30m) to vertical intertidal zone; common in areas of igneous or metamorphic bedrock and high wave exposure.

Cliff with Platform - rock substrate with a wide (>50m) intertidal platform backed by a steep gradient ramp or cliff; generally associated with areas of sedimentary bedrock and high wave exposure; occasionally platform has a thin veneer of coarse sediment (i.e., the platform with veneer of Harper, 1981).

Cliff with Platform and Beach - rock substrate with a wide (>50m) intertidal platform with a beach veneer in the upper part of the intertidal zone; generally associated with sedimentary bedrock and high wave exposure; beach material commonly coarse (pebble, cobble, boulder) and associated with fluvial sediment sources.

Headland/Pocket Beach - alternating rock headlands, most commonly narrow (<20m) cliffs, and small pocket beaches, most commonly mixed-sediment beaches (<30m). This coastal type was not defined in the original classification but was required by the lower resolution map scale used in this project.

Mixed Sediment Beach - steep, poorly sorted beach comprised of sand, granule, pebble, cobble and boulder fractions; along the Strait of Juan de Fuca, sediments commonly grade from finer material at the low water line to coarse at the high water line. Widths generally less than 30m.

Sand Sediment Beach - predominantly sand-sized material; material is very mobile and subject to extensive reworking during storm events and on a seasonal basis (Harper, 1980). Widths to 100m.

Intertidal Flats - wide (>50m) intertidal flat comprised of sand and/or mud; most commonly associated with low wave exposure.

Anthropogenic - shore zones that have been modified by man; substrate may be rubble, concrete, wood or metal.

Estuaries - small lagoons or estuaries most commonly associated with river and stream mouths. Frequently include sand beaches, intertidal flats and marshes.

Rocky Ledges/Reefs and Foreshore Flats

These lines delineate areas exposed at low tide as shown on the National Topographic 1:50,000 maps.

Staging Areas

These symbols refer to potential areas where equipment could be stored, organized, and prepared for distribution to field crews.

Shore Access

Arrows denote the locations where potential cargo transfers to and from a beach or shoreline area could take place (in many cases such sites are available for marine landings only under favourable weather conditions; extreme caution is advised in landing any people or equipment directly onto any exposed shore). The arrows also point to areas where trails or roads provide direct access to the shoreline.

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

Anchorage

Anchorage are described as being either permanent (reliable in most weather conditions) and temporary (contingent on wind and sea conditions).

Helipads and Helicopter Landing Sites

These symbols refer to areas which are either designated helipads (associated with a Canadian Coast Guard base or lighthouse) or areas which appear suitable for landing. All landings are at the pilot's discretion and will require confirmation at the time of a spill.

Access and Countermeasures

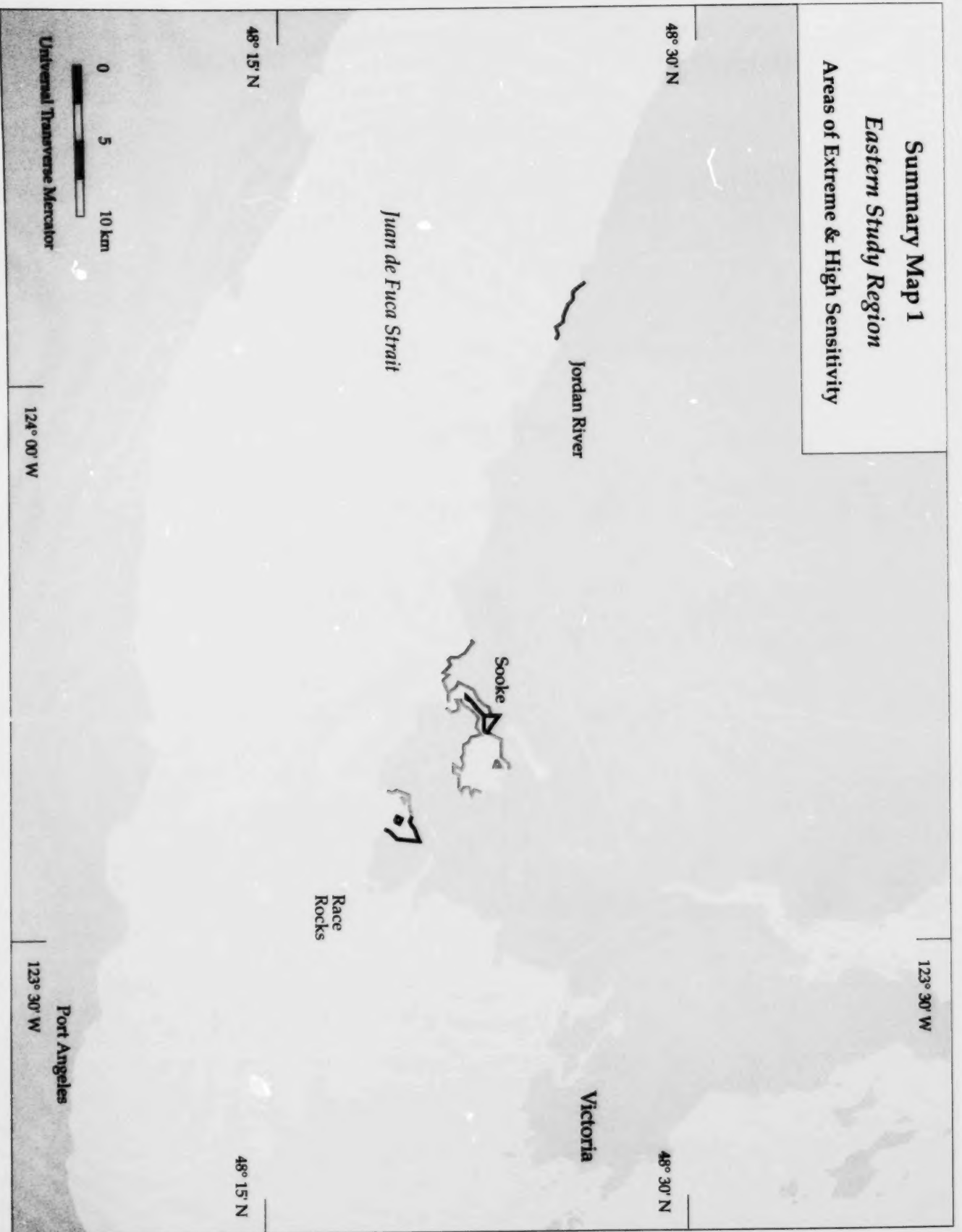
Access and countermeasures options are discussed for each operational map on the facing text pages.



2.0 SUMMARY INFORMATION

Summary Map 1
Eastern Study Region

Areas of Extreme & High Sensitivity



AREAS OF EXTREME & HIGH SENSITIVITY

Summary Map 1 - Eastern Study Area

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45

* See Appendix A

This map presents a summary of the shoreline areas from Race Rocks to Kuitshe Creek that have extreme and high sensitivity to oil spills. Detailed information for Summary Map 1 is presented in Operational Maps 1-9. The rankings are based on available data and the environmental sensitivity ranking system described in Appendix A.

The main element contributing to the extreme and high sensitivities is the human use of these areas. Only in Area 7 did the biological resource element contribute more to the high sensitivity than the human use.

Depending on actual environmental conditions at the time of a spill, other areas may be more or less sensitive than those shown here. Users should refer to the detailed information regarding the human use, biological, shoreline, and special status environmental elements that contribute to the sensitivity of all areas before deciding on a response plan. This information is provided on the operational maps and accompanying text. Appendix A contains a description of the sensitivity ranking system and a breakdown of each area's sensitivity ranking into human use, biological resources, special status areas, and shoreline elements.

Two of the shorelines shown on Summary Map 1 are ranked extreme:

Area 3 NE Becher Bay
Area 12 Sooke River estuary

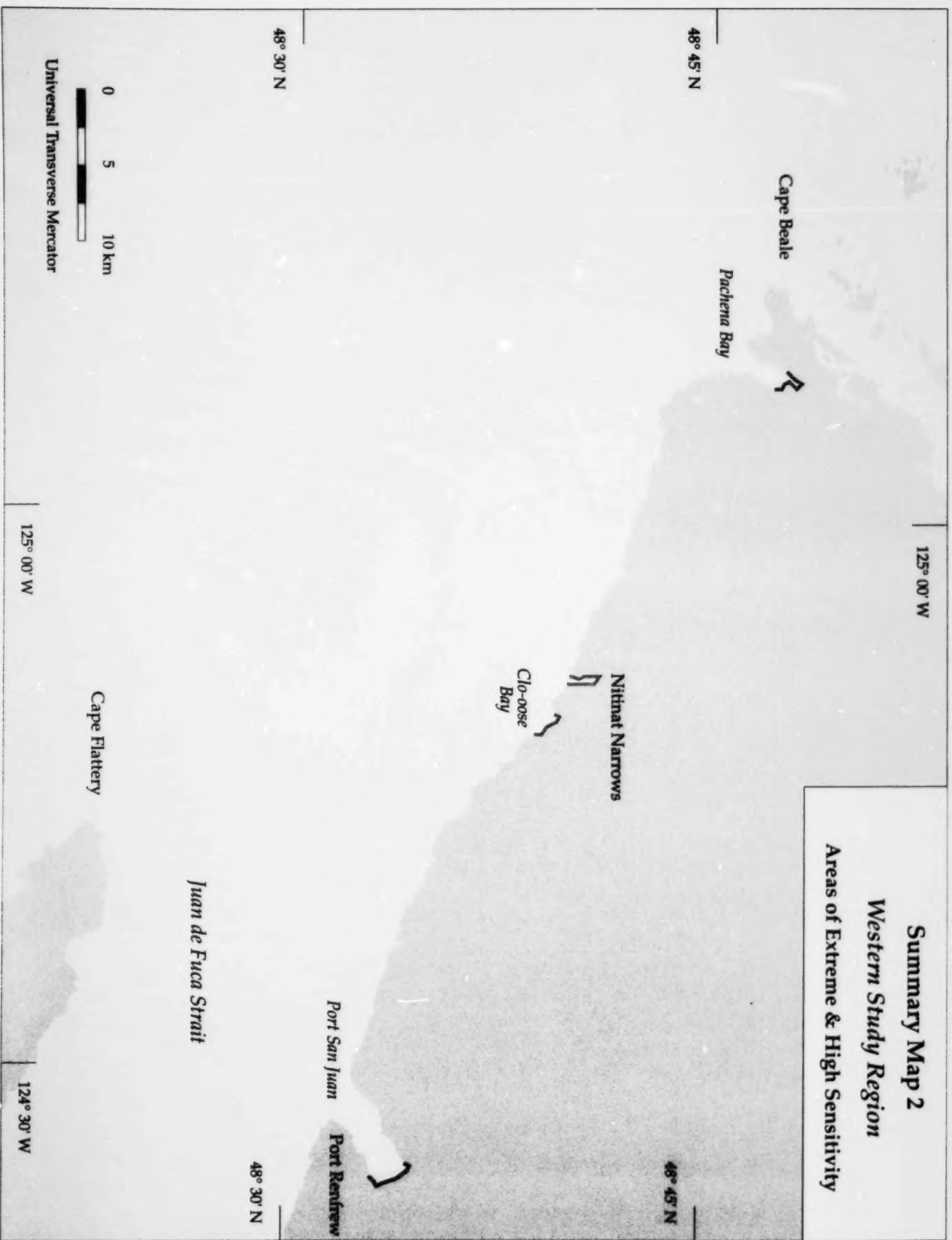
Map 1
Maps 3, 4

The following eight shoreline areas on Summary Map 1 are ranked as high:

Area 4	W Becher Bay	Maps 1, 2
Area 7	E Sooke Harbour	Maps 3, 4
Area 8	SW Sooke Basin	Map 3
Area 9	SE Sooke Basin	Map 3
Area 11	NW Sooke Basin	Map 3
Area 13	Sooke Harbour	Map 4
Area 14	Whiffin Spit to Sooke Bay	Map 4
Area 22	Jordan R. estuary/China beach	Map 7

See Summary Map 2 for an overview of extreme and high sensitivity areas from Parkinson Creek to Cape Beale.

Summary Map 2
Western Study Region
Areas of Extreme & High Sensitivity



AREAS OF EXTREME & HIGH SENSITIVITY

Summary Map 2 - Western Study Area

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45

* See Appendix A

This map presents a summary of the shoreline areas from Parkinson Creek to Cape Beale with extreme and high sensitivity to oil spills. Detailed information for Summary Map 2 is presented in Operational Maps 10-19. The rankings are based on available data and the environmental sensitivity ranking system described in Appendix A.

See Summary Map 2 for an overview of extreme and high sensitivity areas from Race Rocks to Kuitshe Creek.

The main elements contributing to the high and extreme sensitivities of these areas is the human use and special status areas.

Depending on actual environmental condition at the time of a spill, other areas may be more or less sensitive than those shown here. Users should refer to the detailed information regarding the human use, biological, shoreline, and special status environmental elements that contribute to the sensitivity of all areas before deciding on a response plan. This information is provided on the operational maps and accompanying text. Appendix A contains a breakdown of the sensitivity ranking system and a description of each area's ranking into human use, biological resources, special status areas, and shoreline elements.

One area on Summary Map 2 is ranked as extreme:

Area 34	Gordon/San Juan	Maps 11, 12
	Rivers estuary	

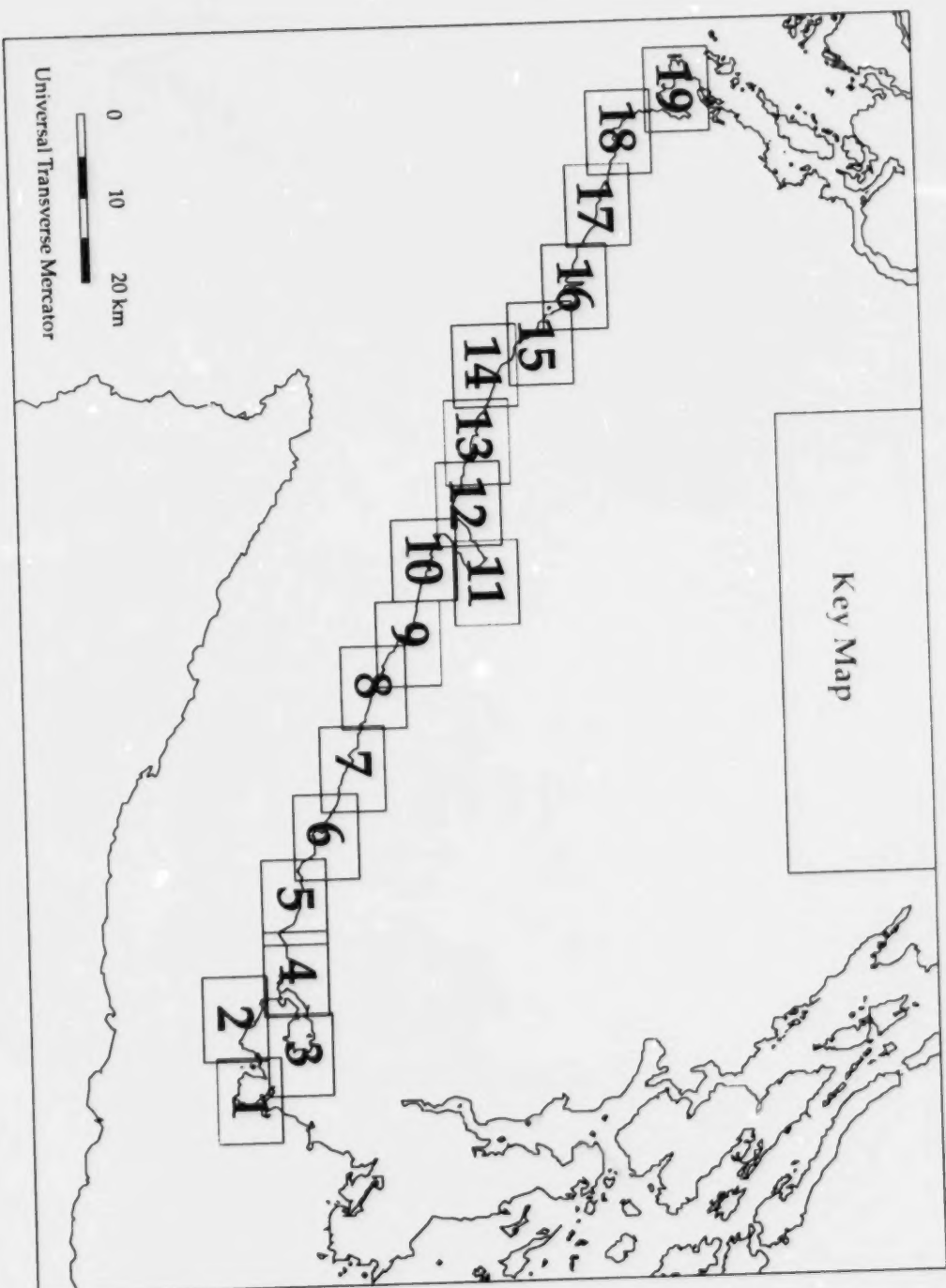
The following three areas on Summary Map 2 are ranked as high:

Area 46	Cheewhat River estuary	Maps 15, 16
Area 48	Nitinal Narrows	Map 16
Area 59	Pachena River estuary	Map 19



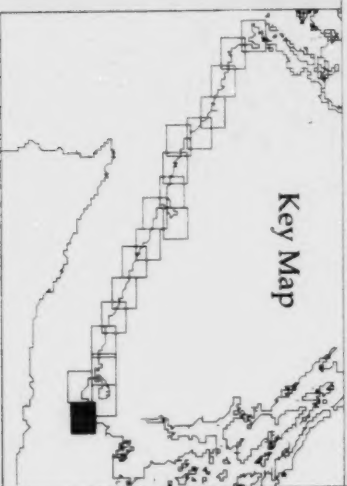
3.0 OPERATIONAL INFORMATION

Shoreline Sensitivity Physical Environment & Countermeasures

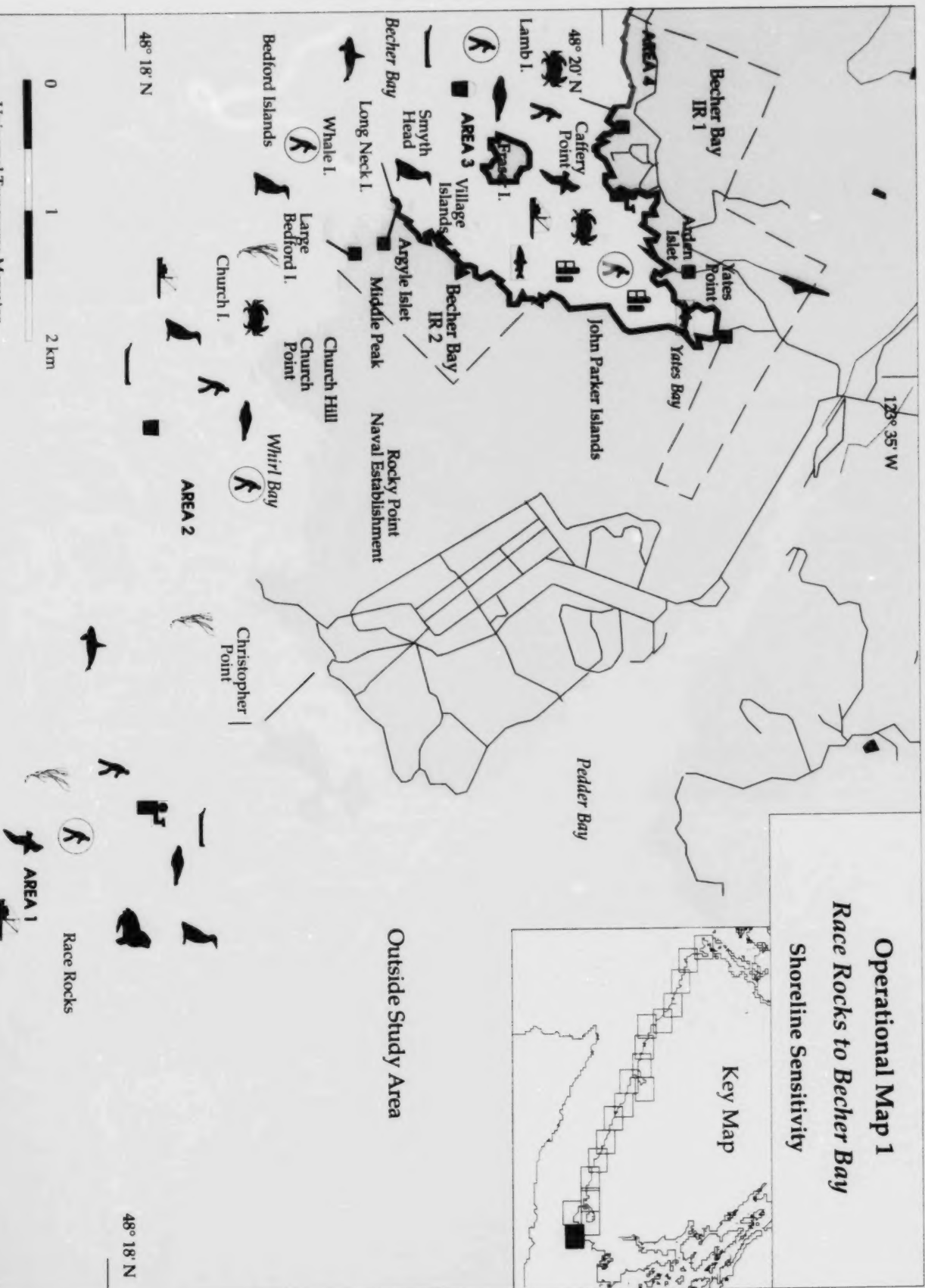


Operational Map 1 Race Rocks to Becher Bay

Shoreline Sensitivity



Outside Study Area



Universal Transverse Mercator

123° 35' W

123° 30' W

48° 18' N

48° 18' N

123° 35' W

Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Sensitivity Ranking
1	Race Rocks	27.3
2	Christopher Pt.-Smyth Head	26.5
3	NE Becher Bay	46.2
4	W Becher Bay	37.5

	Community C		Sea Lion SL
	Aquaculture A		Harbour Seal HS
	Commercial Fisheries CF		Orca Or
	Tourism T		Grey Whale CW
	Industry I		Salmonid Spawning Sa
	Recreation Local RL		Shellfish Sh
	Recreation Diffuse RD		Kelp Beds K
	Intertidal Harvesting SH		Heritage Site High H
	Offshore Harvesting SH		Heritage Site Moderate H
	Bird Colony BC		

C 3 The native people of Becher Bay have homes along the coast in this area.

A 3 Two oyster farm applications are proposed in Eastern Becher Bay - one among the John Parker Islands and one in the inlet north of Yates Point.

CF 1-4 An average of 2 commercial fishing boats per day fish for rockfish from Race Rocks to Bonilla Point from May to December.

CF 2-4 Geoduck are harvested along the shorelines from Christopher Point to Alldridge Point.

CF 2 Abalone are harvested at Church Point.

CF 3 Abalone are harvested along the eastern shores of Becher Bay.

T 1 Organized boat tours originating from Victoria and Sooke take tourists to view the seabirds, sea lions, and whales in the vicinity of Race Rocks all year.

T 3 The Cheanunh Marina and campsite is located in the inlet west of Arden Islet. Fuel, rental boats, picnic tables, and a launching ramp are provided at this marina.

I 3 Canadian Pacific Forest Products Limited have a log booming storage area north of John Parker Islands and Western Forest Products Limited have log booming sites south of John Parker Islands and east of Yates Point.

RL 1 An average of 20 boats per day fish for all 5 species of salmon from June to September and an average of 2 boats per day fish for salmon from October to May in the vicinity of Race Rocks. An average of 2 boats per day fish for halibut from June to September. Lingcod are fished from May to November. Scuba diving is a common activity in the vicinity of Race Rocks.

RL 2 An average of 10 boats per day fish all 5 species of salmon from June to September in Whirl Bay and the Bedford Islands. An average of 2 boats per day fish for salmon from October to May in the Whirl Bay area. An average of 2 boats per day fish for lingcod in Whirl Bay from May to November.

RL 3-4 An average of 20 crab (Dungeness and Red Rock) traps are set from June to September in the Becher Bay area. Occasional diving for Box crabs occurs in the Becher Bay area. An average of 10 boats per day fish all 5 species of salmon from June to September in Becher Bay and an average of 2 boats per day fish for salmon from October to May. An average of 2 boats per day fish for lingcod in

Becher Bay from May to November.

RL 3 There is a private dock located in Arden Islet.

RD 1-3 Abalone are occasionally harvested from the shorelines between Race Rocks and Sheringham Point. About half the number of salmon fishermen also fish for rockfish among the kelp beds from Pedder Bay to Otter Point.

RD 3-4 There is good anchorage for sailing vessels within Becher Bay.

SH 1 Offshore native subsistence harvesting occurs in this area.

SH 2-3 Both offshore and intertidal native subsistence harvesting occurs in these areas.

BC 1 Five species of marine birds breed at Race Rocks: Pelagic cormorant (143), Brandt's cormorant (6), Black oystercatcher (4), Glaucous-winged gull (471), and Pigeon guillemot (30).

BC 2 Black oystercatchers nest on Church Island and Bedford Island (1 pair each). Glaucous-winged gulls (25) also nest on Bedford Island.

BC 3 One pair of Glaucous-winged gulls nest at Argyle Islet.

HS 1 Harbour seals (383 animals) haul out at Race Rocks.

HS 2 A Harbour seal haulout (8 animals) is located on the northeast side of Church Point.

HS 3 Harbour seals (30 animals) haul out off Fraser Island.

SL 1 Both California and Steller sea lions (821 in winter; 300-400 in spring and fall) haul out at Race Rocks.

Or 1-4 Transient pods of orcas may be found along the coast throughout the year. They have been sighted frequently in the vicinity of Becher Bay.

Sh 2 Geoduck (subtidal) occur throughout the area. Abalone (subtidal) are also found along the west side of Church Point.

Sh 3 Geoduck occur throughout the area. Abalone occur in the extreme north end of Becher Bay.

Sh 4 Geoduck occur subtidally along this shoreline.

K 1-2 Moderate densities of kelp occur in these areas.

H 2 Sensitive. This area contains Heritage Site #1.

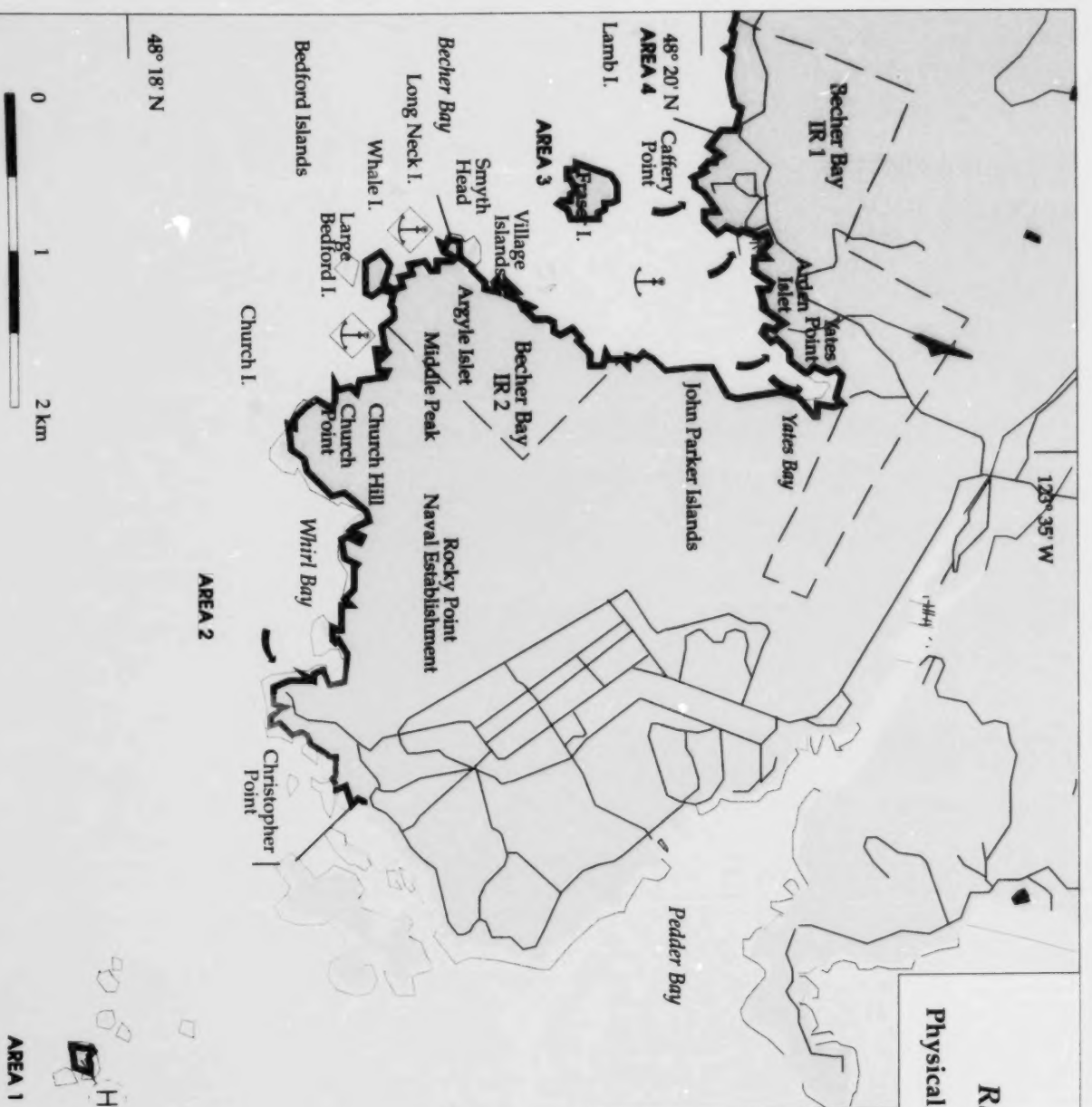
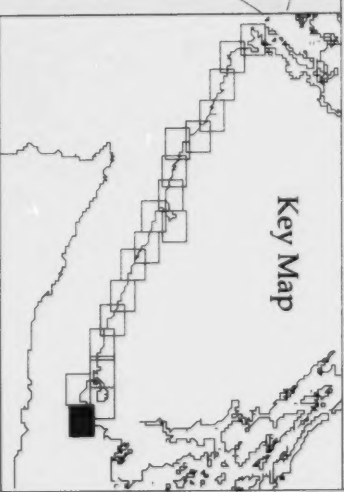
H 3 Extremely sensitive. This area contains Heritage Sites #2-22.

SS 2 The Indian Reserves of Whale Island and Long Neck Island are found in this area. The Rocky Point Naval



Operational Map 1 Race Rocks to Becher Bay

Physical Environment & Countermeasures



Universal Transverse Mercator



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 1 - Race Rocks to Becher Bay

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

High rip tide currents (up to 6 knots) and shoals limit marine access to the shoreline in the vicinity of Race Rocks. The only suitable landing site for a helicopter is the designated area associated with the lighthouse.

Christopher Point is accessible by a road through the Rocky Point Naval Establishment. Trails or gravel roads follow the coastline along Whirl Bay and Middle Peak. The shoreline itself is only accessible by foot. Vessel landings are limited by rough sea conditions along the rugged, rocky coastline. Only sites with good land access are suited for countermeasures operations.

The section from Smyth Head to Yates Bay can only be reached by vessel. Safe landings are possible in the protected, calm waters off several beaches in this area. Caffery Point, Yates Point and Yates Bay are reached by private roads, from Highway 14, and from the sea at the Cheannuh Marina. Shallow-draft vessels may land in Yates Bay, caution is advised due to the presence of deadheads. Temporary anchorages are available to either side of the tombolo spit joining Large Bedford Island to Vancouver Island, behind the Village Islets, and at the log booms behind Fraser Island.

COUNTERMEASURES

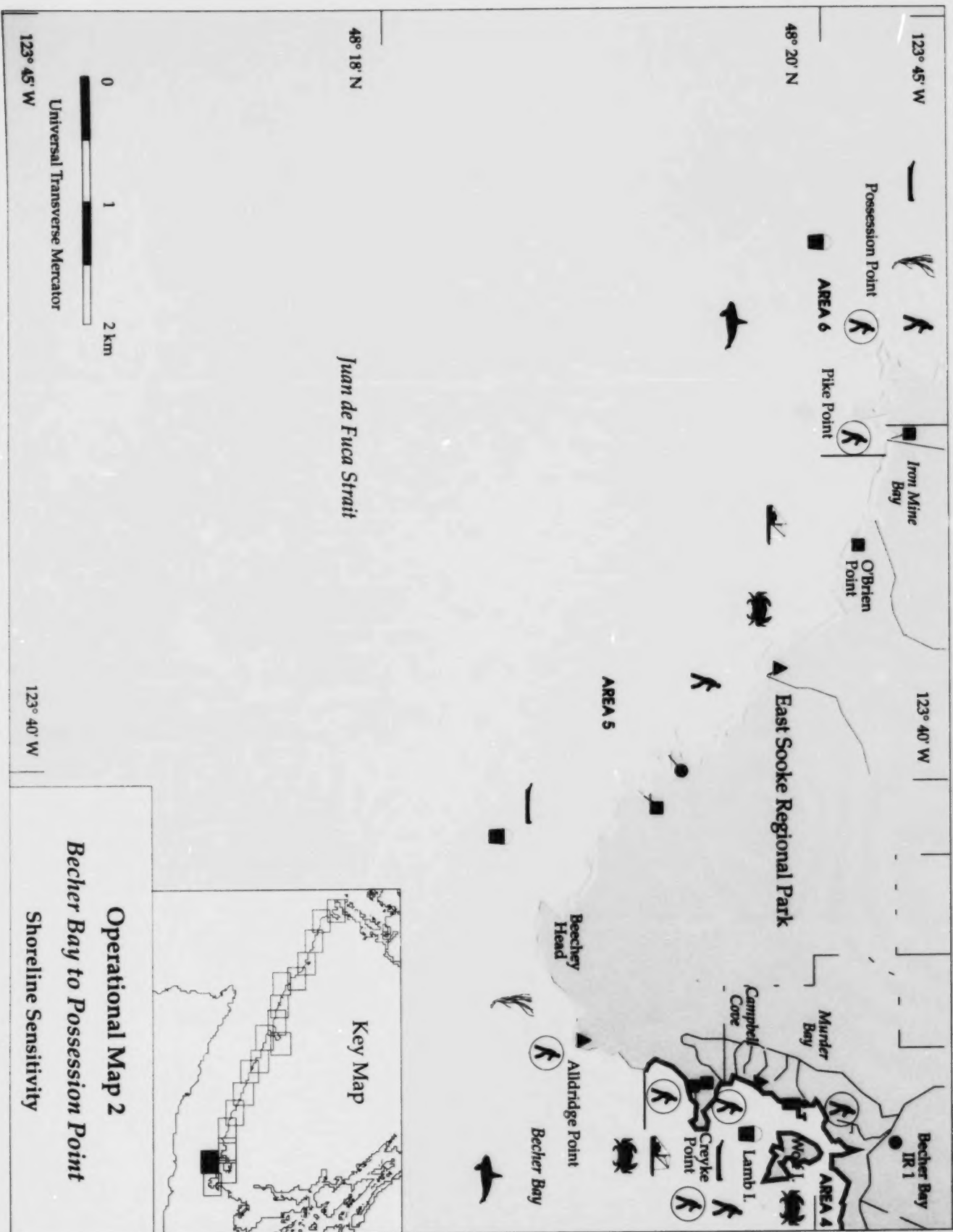
Physical countermeasures will not be effective in the vicinity of Race Rocks. Slicks will quickly disperse in the high currents and waves characterizing this area.

The low bedrock outcroppings in Whirl Bay are exposed to high wave energy. Extensive cleanup is not recommended in these areas; tidal rips and whirls will render marine countermeasures ineffectual and potentially dangerous. One exception is the pocket beach immediately west of Christopher Point which could be approached from the water to allow booming and skimming (sea conditions

allowing).

Protection priorities in the western portion of Becher Bay are the flats north of Yates Point, Cheannuh Marina, and pocket beaches north of Smyth Head. Oil concentrated by light onshore winds could be boomed, although tidal currents of several knots can develop. Water flushing would be possible where isolated beaches are comprised of pebble-boulder veneer over bedrock or coarse sands (limited to areas where booms can be placed along the shore to contain the removed oil). Water blasting of oil stranded high on the steep, rocky shore could also be considered during calm conditions (with prior approval).

The eastern section of Becher Bay is made up of steep cliffs with few sediment beaches. This area will have low oil residence times and would be considered a low priority area for cleanup.



Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Area	Sensitivity Ranking
4	W Becher Bay		37.5
5	Beechy Head		24.4
6	Possession Point		22.3

	Commercial Fisheries CF		Shellfish Sh
	Tourism T		Kelp Beds K
	Recreation Local RL		Heritage Site High H
	Recreation Diffuse RD		Heritage Site Moderate H
	Offshore Harvesting SH		Heritage Site Low H
	Orca Or		

CF 4-6 An average of 2 commercial fishing boats per day fish for rockfish from Race Rocks to Bonilla Point for the months of May to November.

CF 4-5 Geoduck are harvested along the shorelines from Christopher Point to Alldridge Point.

CF 5-6 Clams are harvested along the shorelines from Beechy Head to Sooke Inlet when harvesting is not subject to closures.

T 4 Pacific Lions Marina is located in Murder Bay. Campsites for trailers or tents, fuel, and a launching ramp are available. During summer months, limited moorage is available and a small cafe-store is open.

RL 4 An average of 20 crab traps (for Dungeness and Red Rock crabs) are set daily from June to September in the Becher Bay area. Occasional diving for Box crabs also occurs in the Becher Bay area. An average of 10 boats per day fish all 5 species of salmon from June to September in Becher Bay and an average of 2 boats per day fish for salmon from October to May. An average of 2 boats per day fish for Lingcod in Becher Bay from May to November. There is a private dock located in Murder Bay. There is good anchorage for sailing vessels within Campbell Cove. Creyke Point pocket beaches are heavily used in the summer months.

RL 5 An average of 40 boats per day fish all 5 species of salmon from June to September in the Beechy Head area and an average of 5 boats per day fish for salmon from October to May. Shore fishermen fish all species of salmon all year at Beechy Head. Lingcod fishing occurs off Alldridge Point from May to November. There is a picnic site and a boat launch in East Sooke Regional Park just north of Alldridge Point.

RL 6 An average of 10 boats per day fish all 5 species of salmon from June to September around Possession Point. From June to September, an average of 10 boats per day fish for all 5 species of salmon in Sooke Inlet and from October to May an average of 2 boats per day fish the area. The pocket beaches at Iron Mine Bay are used in the summer months and there is beach access to Possession Point. There are hiking trails throughout East Sooke Regional Park including a trail to a viewpoint at Pike Point.

RD 4-6 An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds from Pedder

Bay to Otter Point. Abalone are occasionally harvested from the shorelines between Race Rocks and Sherningham Point.

RD 4 There is good anchorage for sailing vessels within Becher Bay.

RD 5 There are hiking trails along the beach and throughout East Sooke Regional Park. Scuba divers use the marine areas bounding the park.

RD 6 There are hiking trails along the beach and throughout East Sooke Regional Park.

SH 4-6 Both intertidal and offshore native subsistence harvesting occur in these areas.

Or 4-6 Transient pods of orcas may be found along the coast throughout the year. They have been sighted frequently in the vicinity of Becher Bay.

Sh 4 Geoduck occur subtidally along this shoreline.

Sh 5-6 Clams occur along much of the south-facing shoreline.

K 5-6 Kelp beds occur throughout this area.

H 4 Highly sensitive. This unit contains Heritage Sites #23 - 26.

H 5 Extremely sensitive. This unit contains Heritage Sites #27 - 31.

H 6 Highly sensitive. This unit contains Heritage Site #32.

SS 4-6 East Sooke Regional Park extends from Campbell Cove west to Iron Mine Bay.

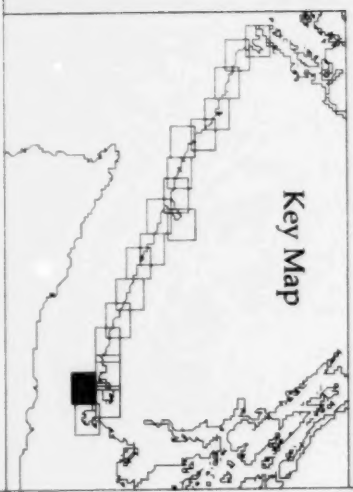
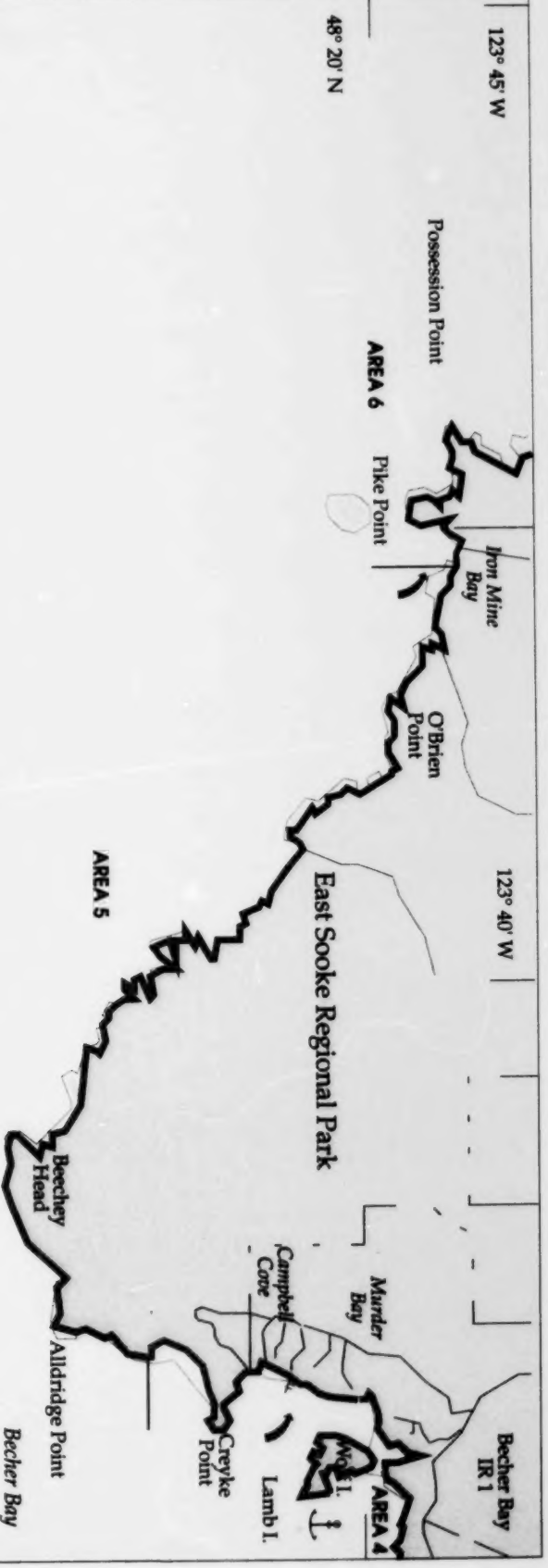
SS 4 The Indian Reserves of Becher Bay and Lamb Island are found in this area.

Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

For detailed information about heritage sites, contact the B.C. Ministry of Environment, Environmental Emergency and Coastal Protection Branch or the B.C. Ministry of Municipal Affairs, Recreation and Culture, Heritage Conservation Branch (in Victoria).





Operational Map 2
Becher Bay to Possession Point
Physical Environment & Countermeasures

PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 2 - *Becher Bay to Possession Point*

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Forshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

Excellent access to Murder Bay/Campbell Cove is provided by private roads leading off a major road from Highway 14. Marine access is provided by the Pacific Lions Marina, and shallow-draft vessels can land at several sheltered beaches.

Trails and logging roads through East Sooke Regional Park provide the only land access to the coast west of Campbell Cove. The shoreline, comprised of predominantly narrow bedrock platforms, is only accessible on foot. This type of shoreline can be reached by shallow-draft vessels during calm sea conditions off the few beach pockets.

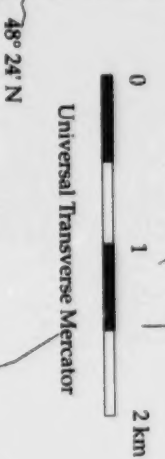
Land access is poor in the vicinity of Iron Mine Bay (the East Sooke Road ends and becomes a trail after Simpson Point; the trail follows the coastline through the park and connects with the beach at Iron Mine Bay). Marine access is good, and safe temporary anchorage is usually available (caution: moderate swell conditions persist during southeast winds).

COUNTERMEASURES

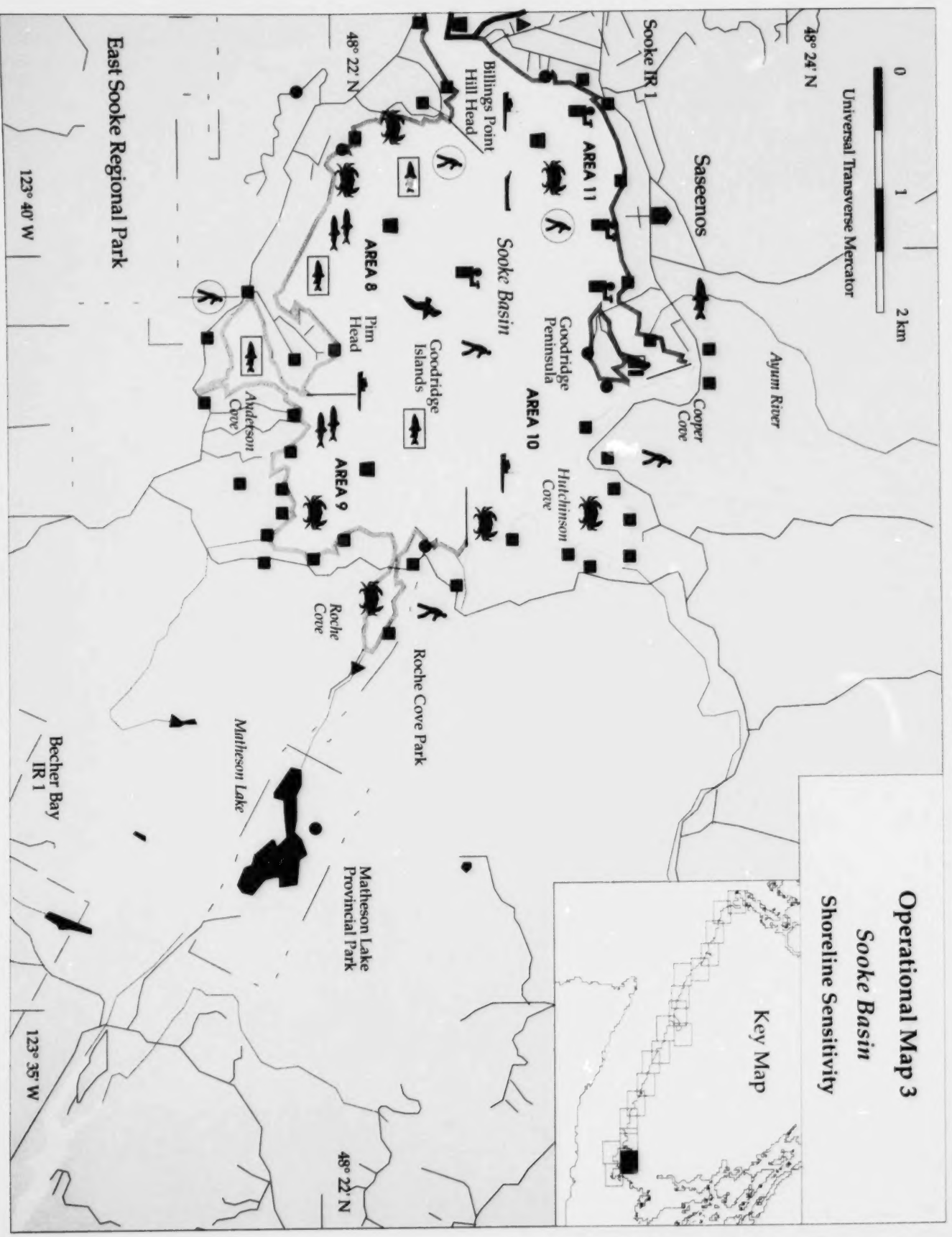
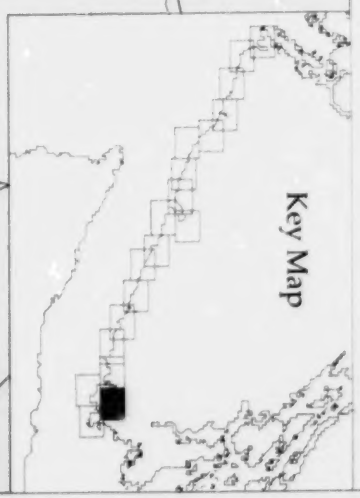
Relatively high tidal currents in Becher Bay could hamper marine cleanup operations. Murder Bay, Campbell Cove and the pocket beach south of Creyke Point are all possible points of oil accumulation. Flushing these oiled pocket beaches and booming the removed oil could be attempted. Exclusion booming will likely be impractical, and skimming of flushed oil is also questionable. Manual methods would be difficult to pursue except at the beaches already noted.

The steep coastline from Allidridge Point to O'Brien Point is comprised of low, rocky outcroppings (relatively steep in many areas). This sector of exposed shore will clean naturally by wave action; extensive application of manual methods is not recommended.

At the mixed sediment beach in Iron Mine Bay, both sea and land access points are available to support oil removal operations; this is a potential collection area for slicks. Flushing of this beach along with booming and skimming the removed oil (water conditions allowing) may be useful. Manual and/or mechanical methods could also be tried at the beach (overland movement of heavy equipment may not be possible).



Operational Map 3
Sooke Basin
Shoreline Sensitivity



Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Area	Sensitivity Ranking
7	E Sooke Harbour		37.2
8	SW Sooke Basin		37.9
9	SE Sooke Basin		42.0
10	NE Sooke Basin		25.3
11	NW Sooke Basin		44.0
12	Sooke River estuary		55.5

■ Community C	— Offshore Harvesting SH
■ Aquaculture A	— Many Birds B
■ Commercial Fisheries CF	— Salmonid Spawning Sa
■ Tourism T	— Herring He
■ Industry I	— Shellfish Sh
■ Recreation Local RL	— Heritage Site High H
■ Recreation Diffuse RD	— Heritage Site Moderate H
■ Intertidal Harvesting SH	— Heritage Site Low H

C 11 Sasenos, part of Sooke, is located here.

A 8 A salmon aquaculture site of 2.5 hectares is located southeast of Hill Head and an oyster aquaculture site of 15 hectares is located west of Pim Head.

A 9 An oyster aquaculture site of 1 hectare in size is located in Anderson Cove. An oyster aquaculture site of 20 hectares and a salmon aquaculture site of 2.23 hectares are located off Goodridge Island.

CF 8-10 Commercial clam harvesting occurs in the pocket beaches from Hill Head to Hutchinson Cove. These areas are subject to closures. Commercial fishing for shrimp and crab occurs throughout Sooke Harbour and Basin.

T 8-11 Fishing charters and harbour tours are prevalent all year in the harbour and basin.

T 11 The Harbour Court Motel is located on the shore west of Goodridge Peninsula and the Bed and Breakfast By the Sea is located north of Billings Point. The Sunny Shores Resort and Marina which is located immediately west of the Goodridge Peninsula is open all year. It has cabins, tent and trailer sites, picnic tables, and full marina facilities including a boat ramp, moorage, and fuel.

I 11 Lamford Forest Products Ltd. has a cedar mill located on Goodridge Peninsula and they have a log booming site in Cooper Cove on the north side of the peninsula.

RL 8 Seagirt Road Beach, which is located southeast of Hill Head, is used in the summer months.

RL 9 Oysters are caught in Anderson Cove where there is also good anchorage for sailing vessels. The north edge of East Sooke Regional Park borders on Anderson Cove where there is a picnic site and a starting point for many of the hiking trails available in the park. There is a 6 km hiking trail located in Sooke Cove Park which is part of the Galloping Goose Park Corridor trail which is 46 km long.

RD 11 There is good anchorage for sailboats in this area. RD 8-11 An average of 70 crab traps (for Dungeness and Red Rock crabs) are set daily from June to September in the Sooke Harbour and Basin areas and an average of 10 crab traps are set daily from October to May. An average of 20 traps or ring nets are set for shrimp daily from September to December in the Sooke Harbour and Basin areas. Sea cucumbers and sea urchins are harvested from the same

area. Abalone are occasionally harvested from the shoreline between Race Rocks and Sheringham Point.

RD 10 The Galloping Goose Park Corridor follows a 46 km long abandoned railway line that runs along the shoreline around Cooper Cove and Hutchinson Cove.

RD 11 The Galloping Goose Park Corridor hiking trail passes through this area approximately 500 m from the shoreline. There is good anchorage for sailboats in this area.

SH 8,11 Both intertidal and offshore native subsistence harvesting occur in these areas.

SH 9,12 Intertidal subsistence harvesting occurs in these areas.

B 8-11 The Sooke Harbour/Basin area is one of the most biologically rich areas in the study region due to the physical protection it offers, the extensive intertidal flats and the presence of the Sooke River estuary. It shelters an abundance of migrating and wintering marine birds, particularly diving ducks.

Sa 11 Chum and Coho salmon (maximum escapements: 4,000, 400 respectively) spawn in the Ayum River.

He 8-9 Herring spawn occasionally along the south shoreline; this is not a significant spawning area.

Sh 8-11 Shrimp and crab spawn throughout the Sooke Harbour/Basin area.

Sh 8-10 Clams inhabit pocket beaches along the south and east shorelines of the Basin.

H 7 Extremely sensitive. This unit contains Heritage Sites #38 - 40.

H 8 Highly sensitive. This unit contains Heritage Sites #41 - 45.

H 9 Extremely sensitive. This unit contains Heritage Sites #46 - 63.

H 10 Extremely sensitive. This unit contains Heritage Sites #64 - 74.

H 11 Extremely sensitive. This unit contains Heritage Sites #75 - 82.

H 12 Extremely sensitive. This unit contains Heritage Site #83.

SS 9 The north edge of East Sooke Regional Park is located in this area as well as Roche Cove Park.



Operational Map 3 - Sooke Basin

Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

For detailed information about heritage sites, contact the B.C. Ministry of Environment, Environmental Emergency and Coastal Protection Branch or the B.C. Ministry of Municipal Affairs, Recreation and Culture, Heritage Conservation Branch (in Victoria).

[illegible]

Note: All other items not shown are present throughout the year.

48° 24' N



Ayum River

Saseenos

Sooke R 1

AREA 11

Goodridge Peninsula

AREA 10

Hutchinson Cove

Sooke Basin



Goodridge Islands

AREA 8

Pim Head

AREA 9

Roche Cove

Roche Cove Park

Matheson Lake Provincial Park

Matheson Lake

Abderson Cove

East Sooke Regional Park

123° 40' W

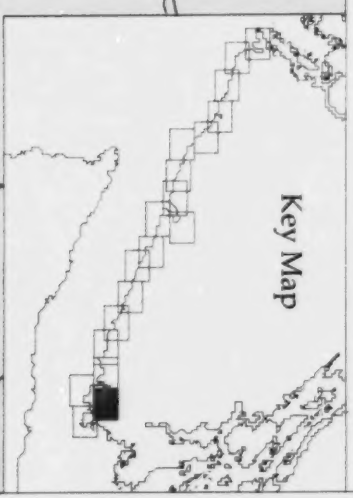
Becher Bay IR 1

123° 35' W

48° 22' N

Operational Map 3 Sooke Basin Physical Environment & Countermeasures

Key Map



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 3 - Sooke Basin

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland / Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Anthropogenic
	Estuaries
	Rocky Ledges / Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

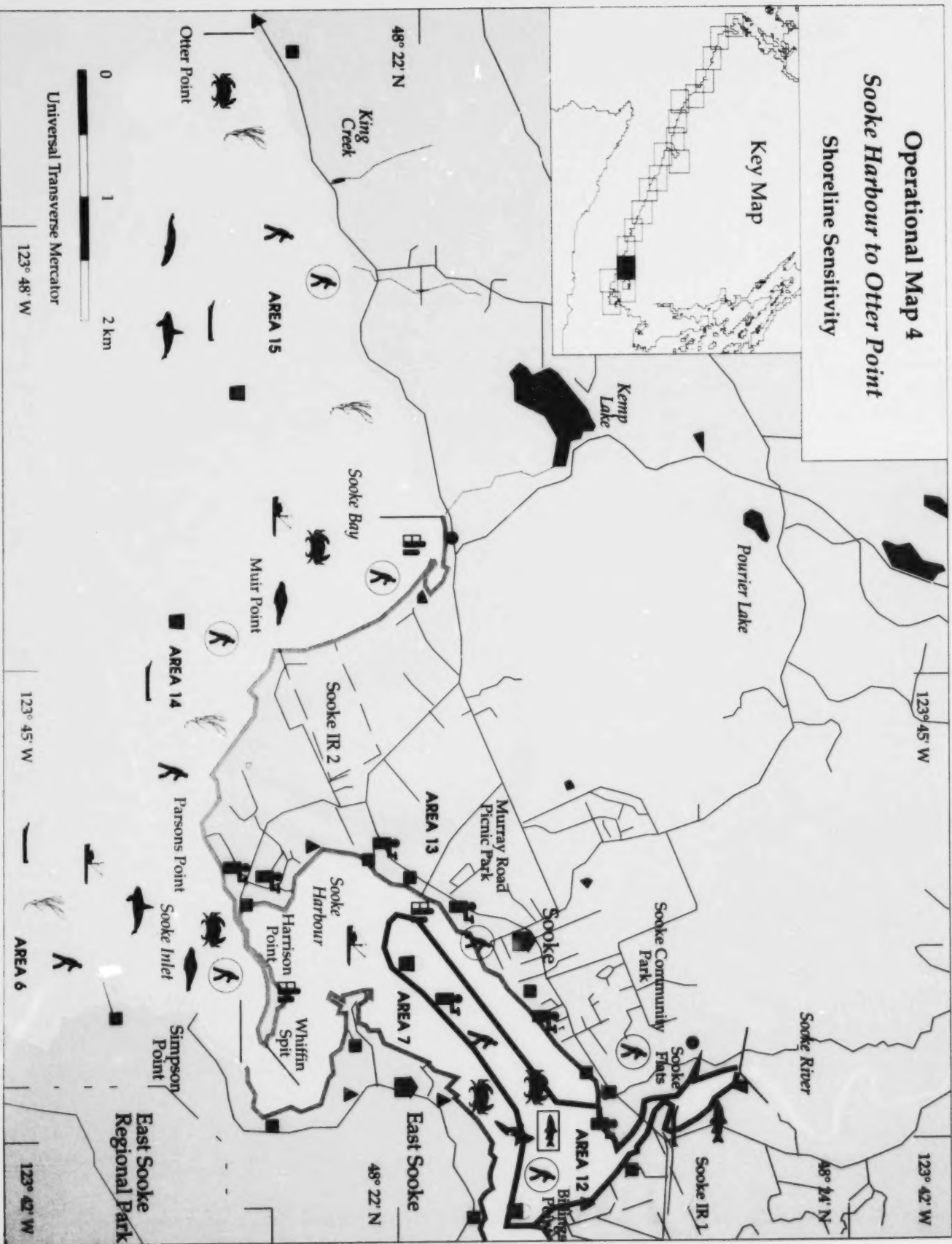
The entire Sooke Basin is well serviced by roads leading to residences located around the basin. The main roads are Highway 14 to the north, Gillespie Road to the west, and East Sooke Road to the south. Marine access is excellent from the harbour, the Sunny Shores Marina, and at the nearby lumber operations on the Goodridge Peninsula. Flat-bottomed craft are recommended to cope with shallow areas within the basin.

COUNTERMEASURES

The highest protection priority involves the complete exclusion of slicks from the Basin if at all possible. In the event that oil travels past Sooke Harbour, booms positioned between Billings Point and Hill Head could be used for diversion purposes (currents of 2 knots can be expected). Failure to prevent slick intrusions into the Basin would require booming operations to protect Anderson Cove, Roche Cove, Hutchinson Cove and Cooper Cove. The north sector of the Basin has a high commercial fishery value and shellfish beds are located around the periphery.

Low-pressure water flushing of oil is recommended where cobble veneered sediments predominate. Cleanup efforts will require careful supervision to minimize the removal of fine sediments and to avoid traffic on the mud flats; clean-up activities will be less environmentally damaging in areas with hard-packed, pebble beaches. Booming and mechanical skimming has a high chance of being successful in the calm waters of Sooke Basin.

Operational Map 4 Sooke Harbour to Otter Point Shoreline Sensitivity



SHORELINE SENSITIVITY

Operational Map 4 - Sooke Harbour to Otter Point

Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

*See Appendix A

No.	Name	Area	Sensitivity Ranking
6	Possession Point		22.3
7	E Sooke Harbour		37.2
12	Sooke River estuary		55.5
13	Sooke Harbour		38.4
14	Whiffin Spit to Sooke Bay		39.5
15	Sooke Bay to Otter Point		26.5

	Community		Harbour
	Aquaculture		Seal HS
	Commercial Fisheries CF		Orca Or
	Tourism T		Grey Whale CW
	Industry I		Salmonid Spawning
	Recreation Local RL		Shellfish Sh
	Recreation Diffuse RD		Kelp Beds K
	Intertidal Harvesting SH		Heritage Site High H
	Offshore Harvesting SH		Heritage Site Moderate H
	Many Birds B		Heritage Site Low H

C7 The community of East Sooke is located in this area.
 C 12 Some of the native people have homes on the Sooke Indian Reserve.
 C 12,13,14 The community of Sooke is located in these areas.
 A 12 An oyster aquaculture site of 5.3 hectares is located west of Billings Point in Sooke Harbour.
 CF 6,14,15 An average of 2 commercial fishing boats per day fish for rockfish from Race Rocks to Bonilla Point for the months of May to November.
 CF 7-13 Commercial fishing for shrimp and crab occurs throughout Sooke Harbour and Basin.
 CF 14,15 Commercial fishing for shrimp occurs throughout Sooke Bay and crab harvesting is concentrated along the north side of Sooke Bay. Geoduck are harvested in Sooke Inlet and Sooke Bay.
 CF 14 Clams are harvested along the shorelines of Sooke Inlet when harvesting is not subject to closures.
 CF 15 East of Otter Point, abalone are commercially harvested.
 T 12,13 Fishing charters, harbour tours and ocean kayak tours are conducted year-round in the harbour and basin.
 T 12 The Sooke River Hotel and the Belvisia Bed and Breakfast are located on the point at the mouth of the Sooke River.
 T 13 Cains House Bed and Breakfast and the Sooke Motel are located on the shores of the central portion of Sooke. Altman's Bed and Breakfast and Tideview Bed and Breakfast Resort are located on the shores around Harrison Point. Sooke Harbour Marina and Campground is located south of Government Wharf.
 T 14 The Sooke Harbour House which offers accommodation is located on the shore east of Parsons Point.
 I 13 The government wharf located in Sooke offers 600 feet of berthing space for fishing vessels with 2 sets of floats. A fish processing plant located on the wharf is used by fishermen to ice their catches. Palco Products, which is also located on the wharf, has fishing supplies to support the fishing industry. Log booming occurs on the north side of Whiffin spit. There are bulk storage facilities located in Sooke.
 I 14 Canadian Pacific Forest Products has a log dump in Sooke Bay.
 RL 6 From June to September, an average of 10 boats per day fish for all 5 species of salmon in the Sooke Inlet and

from October to May an average of 2 boats per day fish the area.
 RL 12 There is a beach at Billings Spit that is used in the summer months. The Sooke Community Park, located on Sooke Flats, has recreational vehicle sites and riverside camping.
 RL 13 There is good anchorage for sailing vessels in Sooke Harbour as well as boat launch ramps along the shores of Sooke. There are picnic areas and beach access points all along Whiffin Spit. Murray Road Picnic Park is located on the water at the base of Murray Road in Sooke.
 RL 13,14 A small effort is expended in the harvest of butter clams in the area of Whiffin Spit when the area is not subject to a closure. Limpits are harvested occasionally throughout the year at low tides from Whiffin Spit to Parsons Point. An average of 1 boat per day fishes all 5 species of salmon throughout the year at Whiffin Spit.
 RL 14,15 From June to September, an average of 10 boats per day fish for all 5 species of salmon in the Sooke Inlet; 5 boats per day fish around Muir Point, and 60 boats per day fish in the Sooke Bay area. From October to May an average of 2 boats per day fish the Sooke Inlet area for all 5 species of salmon; 1 boat per day fishes around Muir Point, and 6 boats per day fish around the Sooke Bay area. An average of 2 boats per day fish from May to November around Muir Point for Lingcod.
 RL 14 There are picnic areas and beach access points all along Whiffin Spit and there are picnic areas and beach access points at Sooke Bay.
 RL 15 There are boat launching ramps at Sooke Bay and at the trailer park east of King Creek.
 RD 6 About half the number of salmon fishermen also fish for rockfish among the kelp beds from Pedder Bay to Otter Point. Abalone are occasionally harvested from the shorelines between Race Rocks and Sheringham Point. There are hiking trails along the beach and throughout East Sooke Regional Park.
 RD 7,12,13 An average of 70 crab traps (for Dungeness and Red Rock crabs) are set daily from June to September in the Sooke Harbour and Basin areas and an average of 10 crab traps are set daily from October to May. An average of 20 traps or ring nets are set for shrimp daily from September to December in the Sooke Harbour and Basin areas. Sea cucumbers and sea urchins are harvested from the shore-area. Abalone are occasionally harvested from the shore-



Operational Map 4 - Sooke Harbour to Otter Point

lines between Race Rocks and Sheringham Point.

RD 12,13 Diving and kayaking are activities practiced in the Sooko Harbour and Basin.

RD 14,15 Abalone are occasionally harvested from the shorelines between Race Rocks and Sheringham Point.

An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds from Pedder Bay to Otter Point.

SH 6,12,14,15 Offshore native subsistence harvesting occurs in these areas.

SH 7,12-15 Intertidal native subsistence harvesting occurs in these areas.

B.7.12-13 The Sooke Harbour/Basin area is one of the most biologically rich areas in the study region due to the physical protection it offers, the extensive intertidal flats and the presence of the Sooke River estuary. It shelters an abundance of migrating and wintering marine birds, particularly diving ducks.

HS 6 A Harbour seal haulout (4 seals) is located off Simpson Point.

HS 14 A Harbour seal haulout (2 seals) is located off Muir Point.

Or 6,14,15 Transient pods of orcas may be found along the coast throughout the year. They have been frequently sighted in the vicinity of Sooke Inlet.

GW 15 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

Sa 12 Four species of salmon spawn in the Sooke River. The maximum recorded escapements are Chum 75,000; Chinook 3,500; Coho 400; and Steelhead 25. In addition, approximately 2,000 sea-run Cut-throat spawn in the Sooke River. The shallow nearshore areas of Sooke Basin and Harbour are important habitat for this species.

Sh 7.12-13 Shrimp and crab spawn throughout the

[illegible]

Note: All other items not shown are present throughout the year.

Sooke Harbour and Basin areas.

Sh 14. Geoduck occur in subtidal areas from Sooke Inlet to Sooke Bay. Clams inhabit the intertidal flats of Whiffin Spit. Crab are harvested on the north side of Sooke Bay; shrimp are found throughout the Bay.

Sh 15 Goodluck and shrimp fisheries extend into this area. Abalone are found on the east side of Otter Point. K 14 Kelp beds are abundant off Parsons Spit and Mullet Point.

K 6,15 Kelp beds occur sporadically along this section of the coast.

H 6,16 Highly sensitive. These areas contain Heritage Sites #33 and 96.

H 7,12,13 Extremely sensitive. These areas contain Heritage Sites #34 - 38 and #83 - 93.

H 14,15 Sensitive. These areas contain Heritage Sites #94 and 95.

SS 6 The western portion of East Sooke Regional Park occurs in this area.

SS 12 Part of the Sooke Indian Reserve is located at the mouth of the Sooke River. Sooke Community Park, which has recreational vehicle sites and riverside camping, is located on Sooke Flats.

camping is located on State Route 14. Part of the Sooke Indian Reserve is located west of Muir Point.

Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

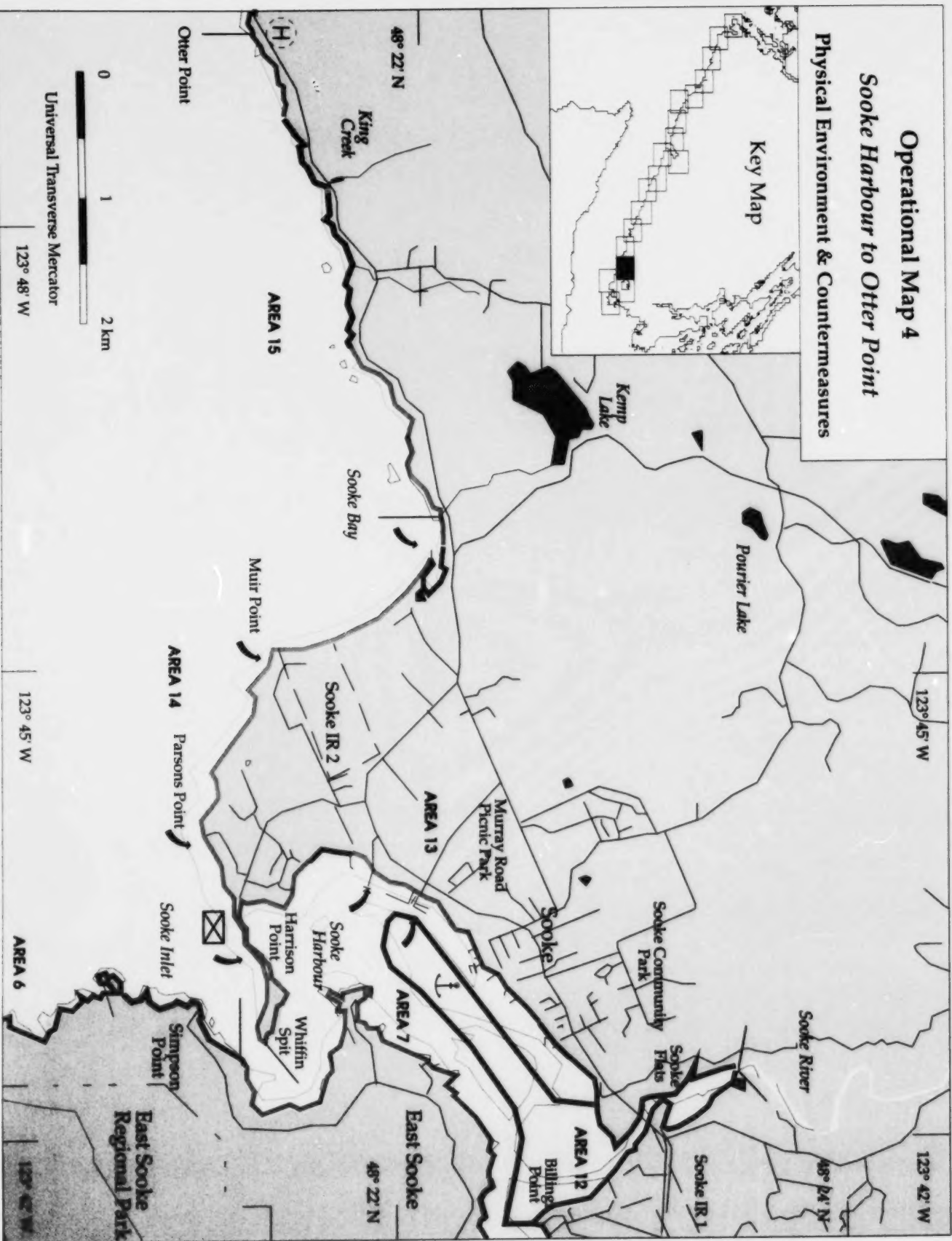
In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councilors (see User's Guide).

For detailed information about heritage sites, contact the B.C. Ministry of Environment, Environmental Emergency and Coastal Protection Branch or the B.C. Ministry of Municipal Affairs, Recreation and Culture, Heritage Conservation Branch (in Victoria).

Operational Map 4

Sooke Harbour to Otter Point

Physical Environment & Countermeasures



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 4 - Sooke Harbour to Otter Point

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

Highway 14 (with connecting residential roads) runs along the shore for the entire section covered by Map 4. Direct shoreline access is limited to areas with low-slope beaches.

Sooke Harbour has good access via local and residential roads from Highway 14 to the west and East Sooke Road to the east. Marine access is also excellent through the Sooke Harbour Marina and the Government Wharf (flat-bottom craft are required for shallow mud flat areas).

Whiffin Spit is connected via the Whiffin Spit road from Highway 14 (Richview Road joins Parsons Point at the end of this road). The parking lot at the base of Whiffin Spit could serve as a staging area.

The western area (as far as Muir Point) is served by McMillan Road (in from Highway 14 via Whiffin Spit Road and Wright Avenue). The logging operations at Sooke Bay are connected via a road adjacent to Highway 14. There are safe marine landing sites at the logging operations, but boat landings at other beach areas depend on wave conditions at the time.

COUNTERMEASURES

Key areas for protection booming at high tide include the mouth of the Sooke River and the mud flats in Sooke Harbour. The commercial fishery along the western shore will require immediate response action. Deflection booming at the entrance to Sooke Inlet is likely to prove ineffective due to high currents (reaching 4 knots), the wide entrance, and breaking surf in this area.

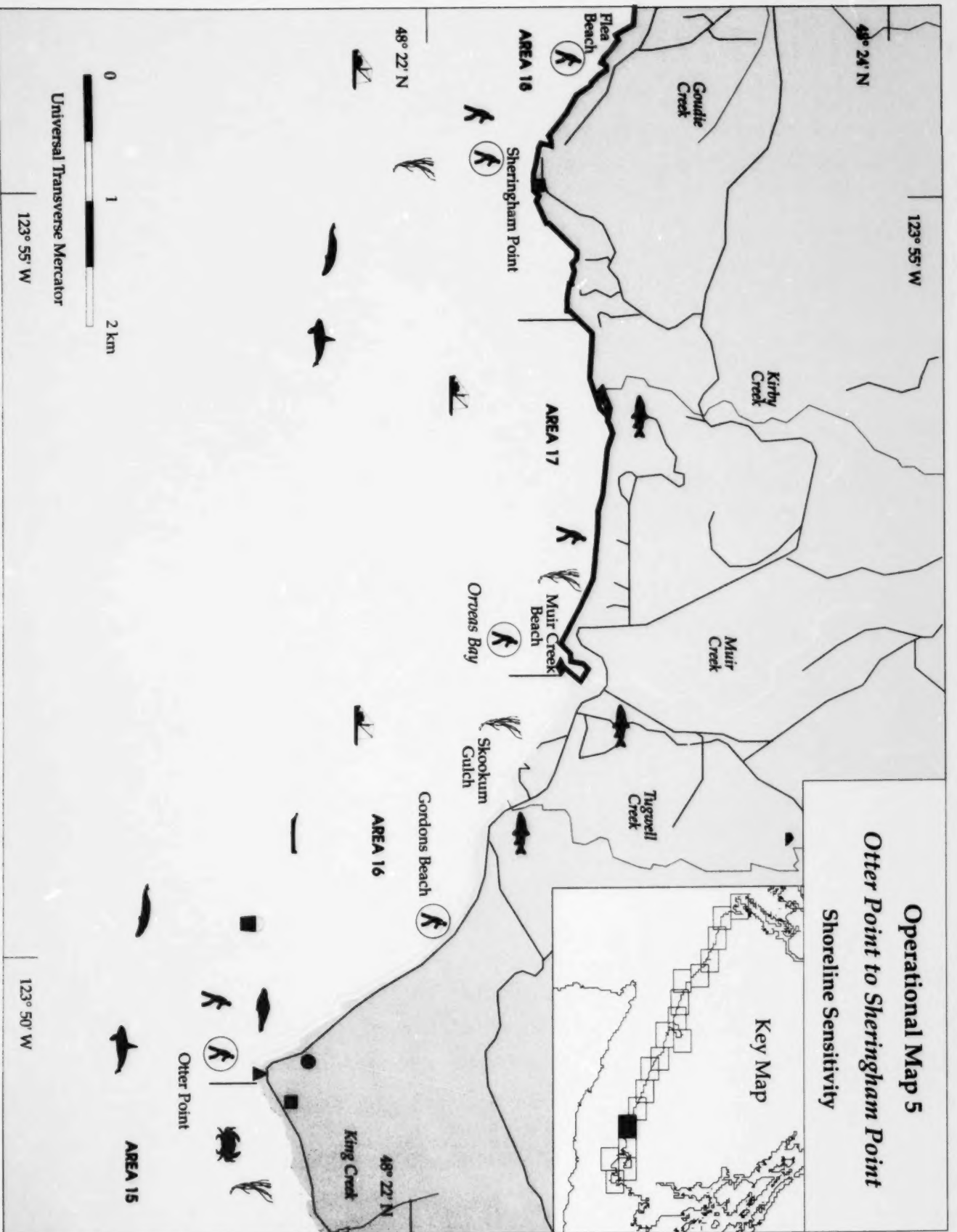
Sticks which reach the south shore of Whiffin Spit will tend to collect near the centre of the spit. Manual cleanup is favoured over water-flushing methods if steps are taken to minimize disruption to the large clam population located along the Spit.

To the west of Muir Point, bedrock platform and coarse beaches will require manual cleanup. Water-flushing is not recommended because there is a low chance of being able to contain and skim the oil. Bioremediation could be tried in Sooke Bay especially along stretches of beach with thick layers of pebble and cobble. The log-sorting operation can be readily boomed to prevent the entry of oil.

West of Sooke Bay, as far as Otter Point, the pocket beaches become more isolated and are interspersed with steep rock outcrops. Nearby roads provide an opportunity to manually clean the pebble/cobble beaches. Bioremediation is an additional option.

Manual flushing of stranded oil may promote deeper penetration of the oil; this technique is not recommended for beaches with thick pebble layers. In many cases, the effectiveness of natural cleaning could exceed the value of countermeasures operations (e.g., the rocky headlands at Otter Point).

Operational Map 5 Otter Point to Sheringham Point Shoreline Sensitivity



Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Area	Name	Sensitivity Ranking
15		Sooke Bay to Otter Point	26.5
16		West of Otter Point	27.1
17		Orveas Bay	19.6
18		Sheringham Point	16.5

	Commercial Fisheries CF		Salmonid Spawning Sa
	Recreation Local RL		Shellfish Sh
	Recreation Diffuse RD		Kelp Beds K
	Intertidal Harvesting SH		Heritage Site High H
	Offshore Harvesting SH		Heritage Site Moderate H
	Orca Or		Heritage Site Low H
	Grey Whale GW		

CF 16-18 An average of 2 commercial fishing boats per day fish for rockfish from Race Rocks to Bonilla Point in the months of May to November.

CF 18 From July to mid-September, an average of 30 commercial fishing boats per day fish for all 5 species of salmon in the area from Sheringham Point to Port San Juan.

Sockeye and Pink salmon are the most common catches. RL 16 From June to September, an average of 60 boats per day fish for all 5 species of salmon around Otter Point and 5 boats per day fish around Orveas Bay. From October to May, an average of 1 boat per day fishes for salmon around Otter Point. Gordons Beach, which is located east of Skookum Gulch, is used in the summer months. There are boat launch ramps at Gordons Beach and at Skookum Gulch.

RL 17 An average of 5 boats per day fish for all 5 species of salmon from June to September in Orveas Bay. Muir Creek Beach, which is located at the mouth of Muir Creek, is used in the summer months.

RL 18 From May to November, an average of 1 boat per day fishes for Lingcod around Sheringham Point. An average of 5 boats per day fish for all 5 species of salmon from June to September around Sheringham Point. An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds around Sheringham Point. There is access by vehicle to Flea Beach which is west of Sheringham Point. The lighthouse at Sheringham Point provides a viewing point of the coast. Diving is an activity common around the area.

RD 16-18 Abalone are occasionally harvested from the shorelines between Race Rocks and Sheringham Point. Mussels and Gooseneck barnacles are occasionally harvested from Otter Point to Bonilla Point. From May to November, an average of 5 boats per day fish for Lingcod in the area from Otter Point to Bonilla Point. RD 16 An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds from Pedder Bay to Otter Point.

SH 16 Both offshore and intertidal subsistence harvesting occur in this area.

HS 16 A Harbour seal haulout (1 seal) is located at Otter Point.

Or 15-18 Transient pods of orcas may be found along the

coast throughout the year.

GW 15-18 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

Sa 16 Tugwell Creek supports a small run of 3 salmonid species distributed as follows:

Species	Maximum Recorded Escapement
Chum	3,500
Coho	200
Steelhead	25

Sa 17 Muir and Kirby Creeks support small runs of 3 salmonid species with the following distributions:

	Maximum Recorded Escapement
Muir	Chum 3,500 Coho 200 Steelhead 25
Kirby	Chum 1,500 Coho 200 Steelhead 25

Sh 15 Geoduck and shrimp fisheries extend into this area. Abalone are found on the east side of Otter Point.

K 15 Kelp beds occupy the coastline east of Otter Point.

K 16-17 Extensive kelp beds occupy the coastline between Tugwell and Kirby creeks.

K 18 Kelp beds occupy the coastline around Sheringham Point.

H 15 Sensitive. This unit contains Heritage Site #95.

H 16 Highly sensitive. This unit contains Heritage Sites #96 & 97.

H 18 Sensitive. This unit contains Heritage Site #98.

Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

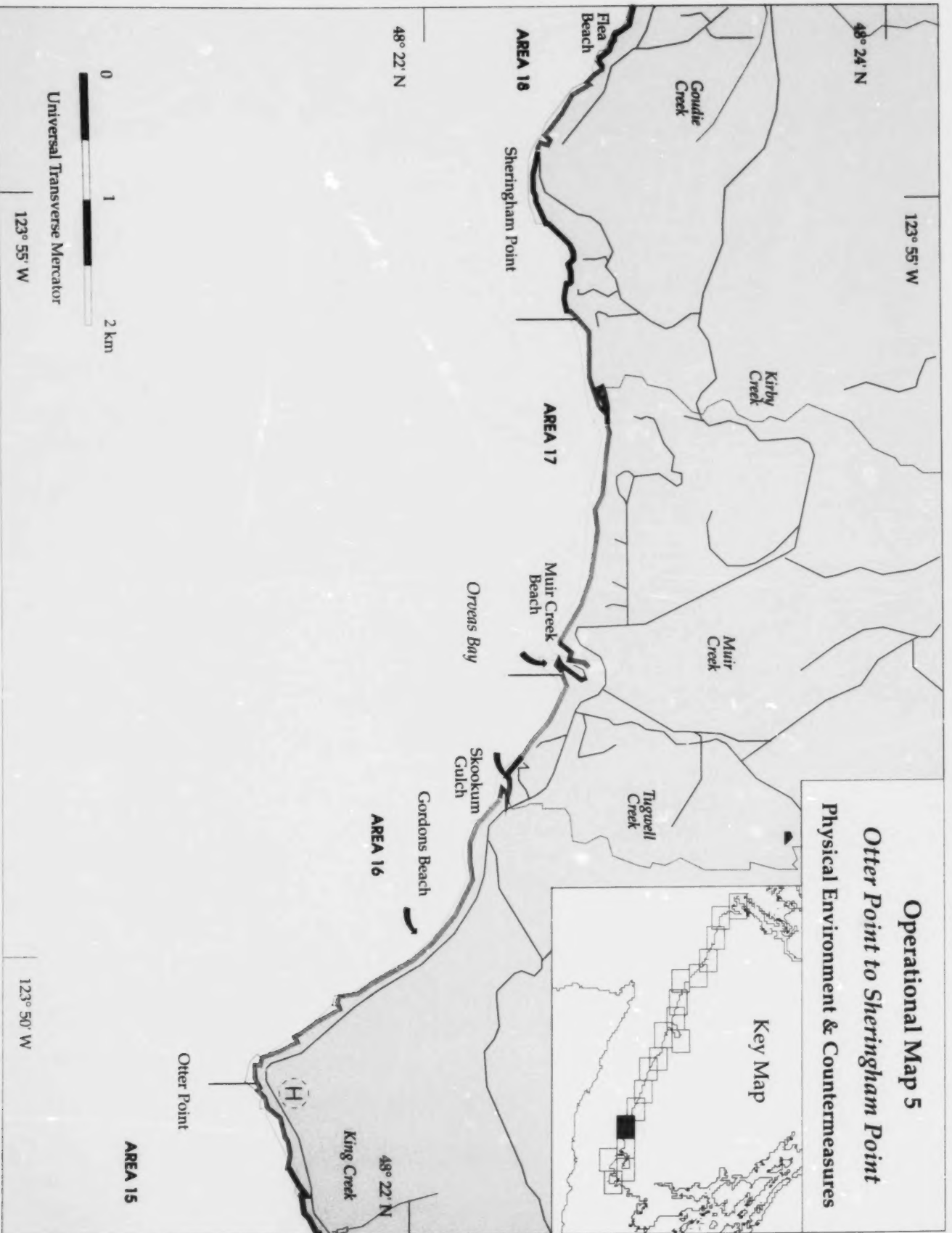
12



Operational Map 5

Otter Point to Sheringham Point

Physical Environment & Countermeasures



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 5 - Otter Point to Sheringham Point

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

Highway 14 follows the coastline from Otter Point to Muir Creek before turning inland. Gordons Beach, Skookum Gulch and Muir Creek provide access points in this area. Marine landings are often restricted by steep beaches, variable sea states, and surf.

The only road between Muir Creek and Sheringham Point is at the lighthouse at Sheringham Point; steep bedrock outcrops prohibit direct transport to the shoreline at this point. Marine landings are not recommended around Sheringham Point. Boat transport throughout the remainder of the section depends on marine conditions.

COUNTERMEASURES

Otter and Sheringham Points are comprised of steep bedrock outcroppings which are exposed to high wave energy. Stranded oil would have a short residence time in this area.

Shoreline cleanup in this area would likely focus on beaches associated with residences at Gordons Beach, and at the mouths of Tugwell, Muir and Kirby Creeks. Muir Creek is the only creek where booming and skimming could be attempted (most likely to be effective at high tide). Protection booming of the log sorting operation may prove necessary. Sufficient space exists at the Muir Creek parking area to stage the required response gear.

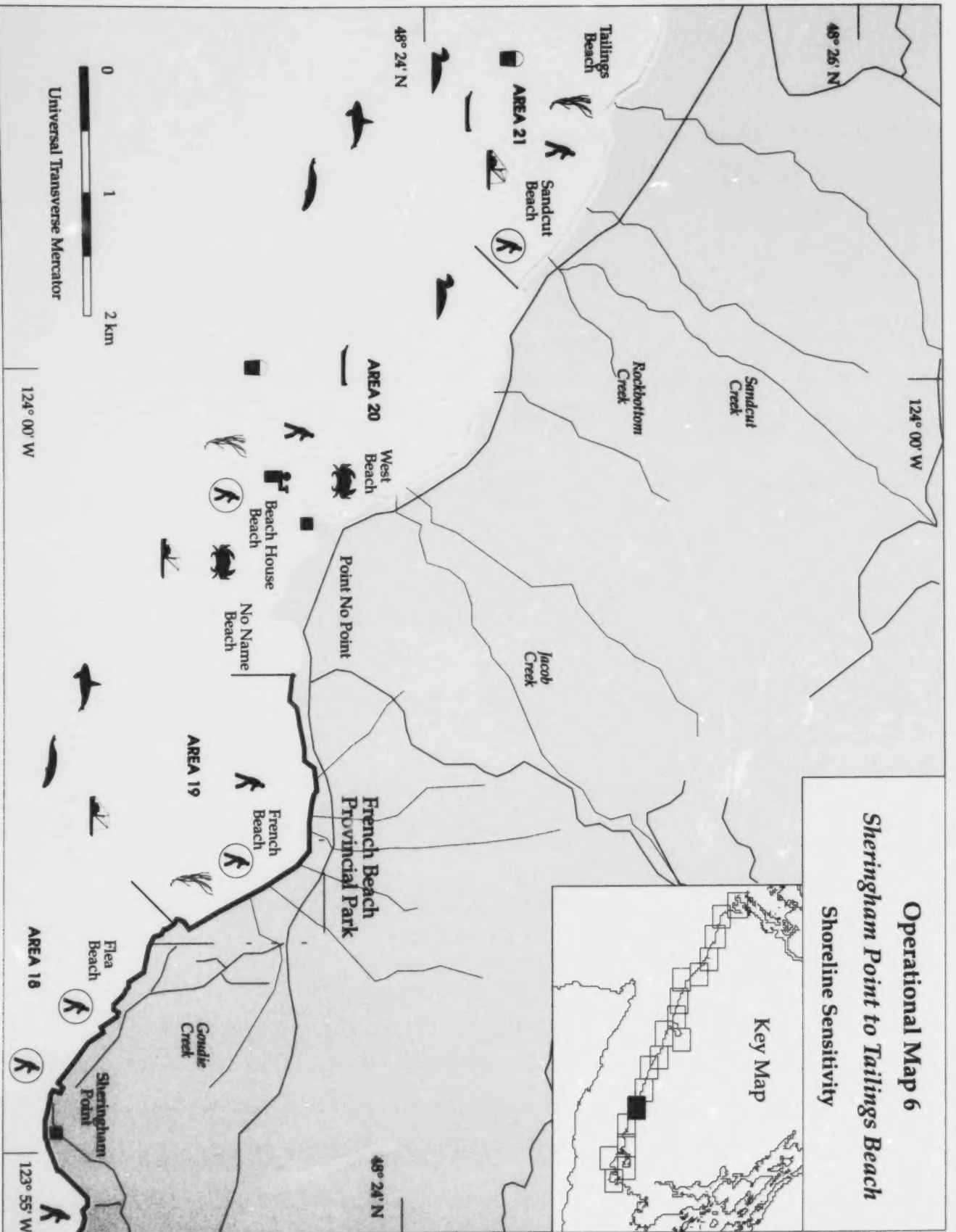
Bioremediation could be considered where beach sediments are comprised of uniform size, coarse, thick sediments (including pebble and cobble); examples are the two pocket beaches just west of Otter Point where oil accumulations are likely.

Water flushing of surface oils could also be implemented in the sections of coarse sediment beach east of Sheringham Point and Muir Creek (when oil can be contained and

skimmed along the shore - sea conditions permitting). The intervening section of finer sediment veneer backed by low cliffs is not suited to physical cleanup methods.

Flea Beach to the west of Sheringham Point, and associated pocket beaches, have high recreational values; these areas would require manual cleanup, including flushing and skimming (sea conditions permitting).

Operational Map 6 Sheringham Point to Tailings Beach Shoreline Sensitivity



SHORELINE SENSITIVITY

Operational Map 6 - Sheringham Point to Tailings Beach

Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Area	Sensitivity Ranking
18	Sheringham Point		16.5
19	French Beach		16.2
20	Point No Point		28.2
21	E Jordan River		25.1

	Commercial Fisheries CF		Moulting Birds MB
	Tourism T		Orca Or
	Recreation Local RL		Grey Whale CW
	Recreation Diffuse RD		Shellfish Sh
	Intertidal Harvesting SH		Kelp Beds K
	Offshore Harvesting SH		Heritage Site Moderate H

CF 18-21 An average of 2 commercial fishing boats per day fish for rockfish from Race Rocks to Bonilla Point in the months of May to December. From July to mid-September, an average of 30 commercial fishing boats per day fish for all 5 species of salmon in the area from Sheringham Point to Port San Juan. Sockeye and Pink salmon are the most common catches.

CE 20 Crab are harvested in the vicinity of Point No Point. T 20 The Point No Point Resort is located in this area and it provides log cabins for tourists.

RL 18 From May to November, an average of 1 boat per day fishes for lingcod around Sheringham Point. An average of 5 boats per day fish for all 5 species of salmon from June to September around Sheringham Point. An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds around Sheringham Point. There is access by vehicle to Flea Beach which is west of Sheringham Point. The lighthouse at Sheringham Point provides a viewing point of the coast. Diving is an activity common around the area.

RL 19 French Beach provides campsites, a picnic area, a hiking trail, and a viewpoint to watch the killer whales.

RL 20 An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds around Point No Point. More than 1 boat per day fishes for all 5 species of salmon around Point No Point from June to September. The Juan de Fuca viewpoint and picnic area, which are maintained by Western Forest Products Limited, are located on the point.

RL 21 Sandcut Beach, maintained by Western Forest Products Limited, is accessed by a trail that takes 5 minutes to walk.

RD 18 Abalone are occasionally harvested from the shorelines between Race Rocks and Sheringham Point.

RD 18-21 Mussels and Gooseneck barnacles are occasionally harvested from Otter Point to Bonilla Point. From May to November, an average of 5 boats per day fish for lingcod in the area from Otter Point to Bonilla Point.

RD 21 There is hiking along the beach from Sandcut Creek to China Beach.

SH 20-21 Both offshore and intertidal native subsistence harvesting occur in these areas.

MB 20-21 Concentrations of moulting Surf scoters occur

around the headland bordering these areas in late July and August. These birds occur in large flocks (150 birds) and are vulnerable to oiling due to their flightless condition.

Or 18-21 Transient pods of orcas may be found along the coast throughout the year.

GW 18-21 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

Sh 20 Crab are fished east and west of Point-No-Point.

K 19-21 Kelp beds occur sporadically along this section of the coast.

H 18 Sensitive. This unit contains Heritage Site #98.

H 20 Sensitive. This unit contains Heritage Site #99.

SS 18-19 French Beach Provincial Park is located in this area.

SS 20 The Juan de Fuca Viewpoint, maintained by Western Forest Products Limited has a picnic site and is accessed by a trail which takes 5 minutes to walk.

SS 21 A short 5 minute walk to Sandcut Beach is maintained by Western Forest Products Limited.

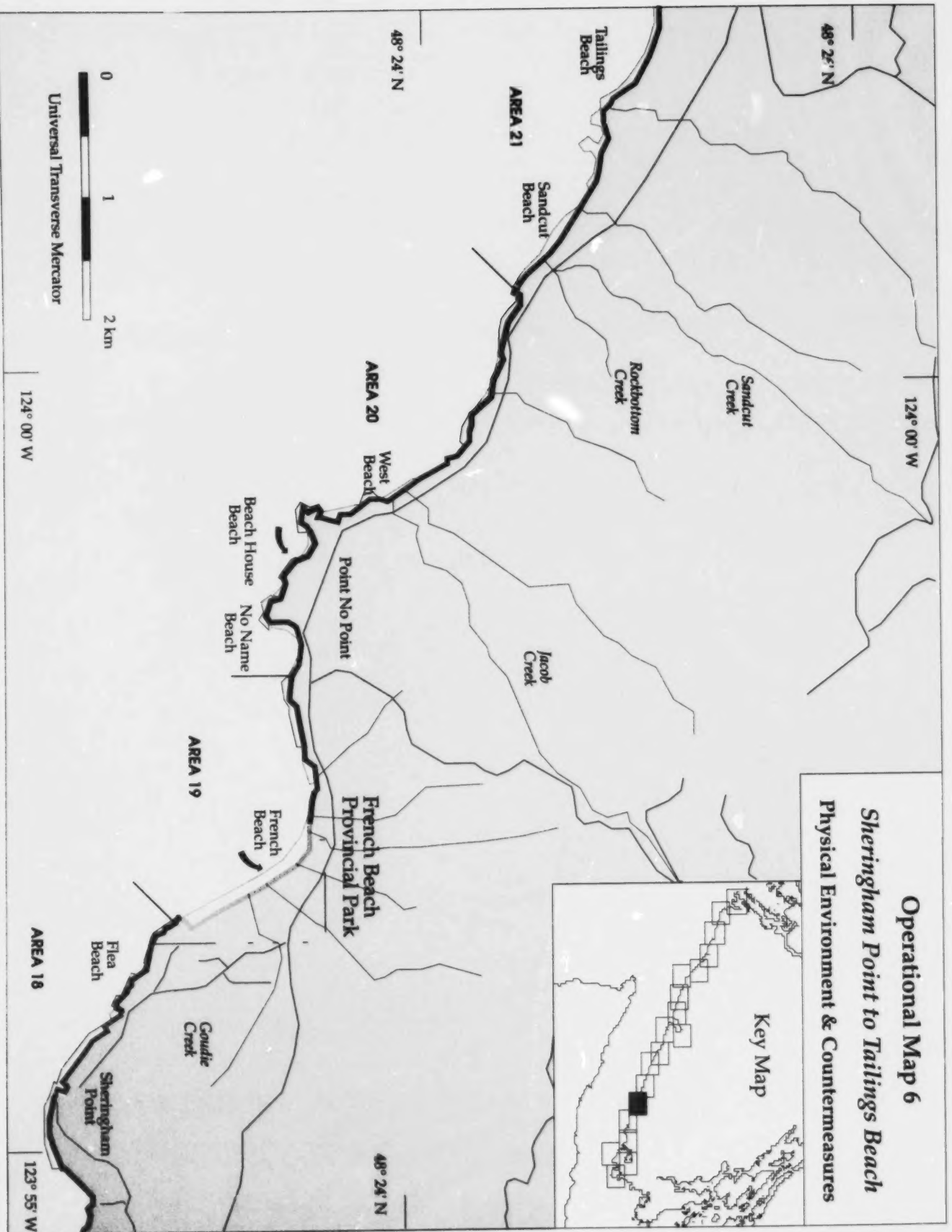
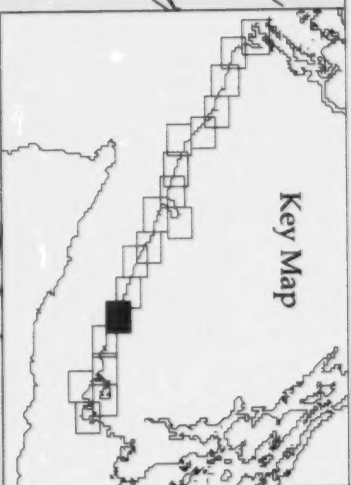
Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

For detailed information about heritage sites, contact the B.C. Ministry of Environment, Environmental Emergency and Coastal Protection Branch or the B.C. Ministry of Municipal Affairs, Recreation and Culture, Heritage Conservation Branch (in Victoria).



Operational Map 6 Sheringham Point to Tailings Beach Physical Environment & Countermeasures



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 6 - *Sheringham Point to Tailings Beach*

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland / Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges / Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

French Beach is reached by road through the Provincial Park. Marine landings could be made with shallow-draft vessels on the beach (swell permitting).

Although a road leads to Point No Point from Highway 14, direct movement of equipment to the shore would be limited to trails located at the rocky headland. Rocks and high waves prevent safe boat landings. One exception, the small pocket beach called Beach House Beach on the eastern side of the point, may allow landings of shallow-draft vessels.

Highway 14 runs inland to the west of the Jordan River preventing effective road transport of people and equipment. Vessel landings along this section are dependent on marine conditions, and are often prohibited by large boulders and rock platforms.

COUNTERMEASURES

Many of the beaches noted in this sector feature relatively narrow bands of pebble mixed with sand, together with boulders distributed in the intertidal zone, and a covering of logs at the backshore. Bioremediation techniques could be tried where thick beach sediments consist of uniformly distributed pebble or cobble materials.

Flea Beach, to the west of Sheringham Point, and other associated small recreational beaches would require manual cleanup, including flushing, and skimming (sea conditions permitting).

French Beach has the highest recreational use in this sector. Its sandy beaches are amenable to cleanup using mechanical and manual methods. Heavy equipment could be assembled and deployed by vessel or road. Storage of

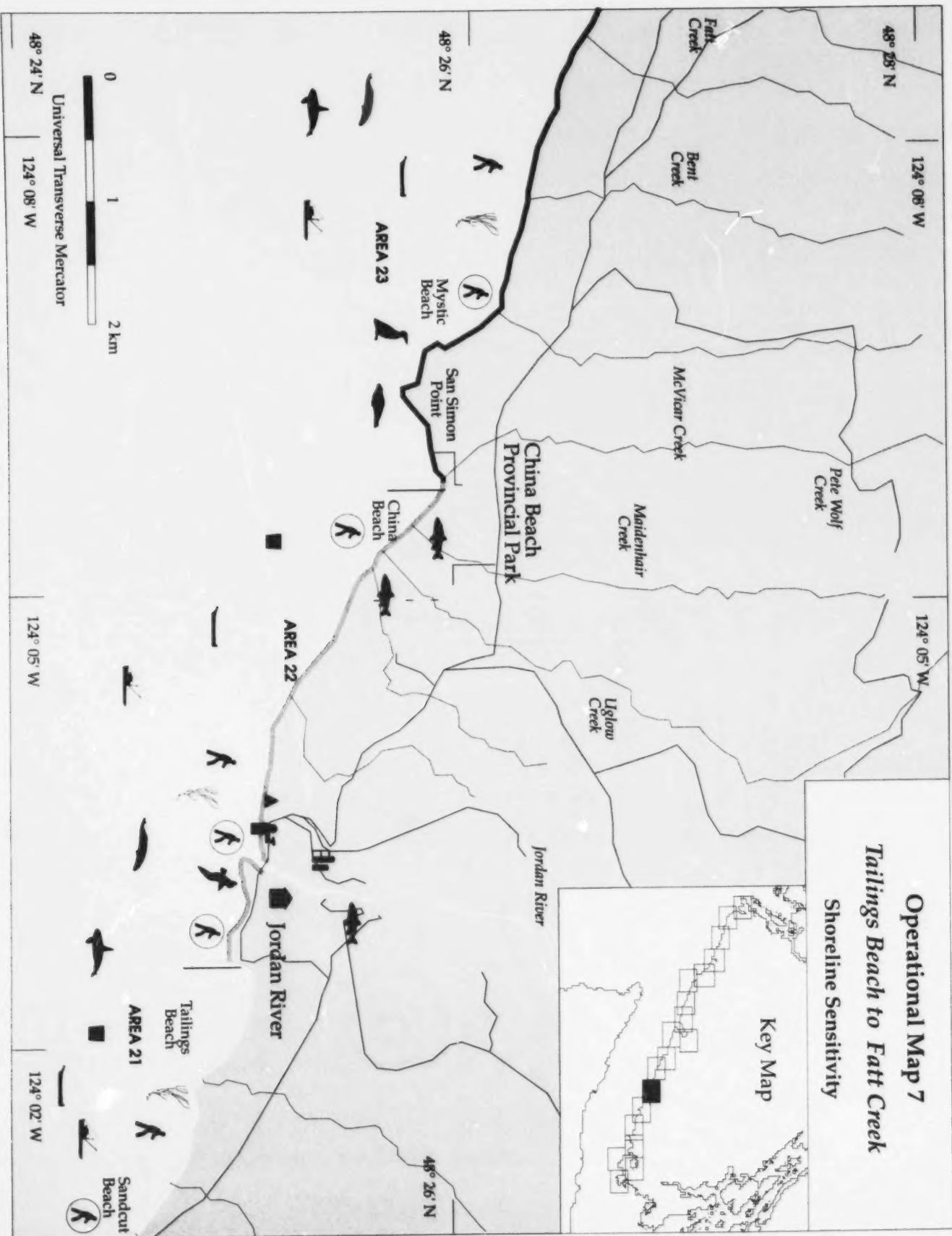
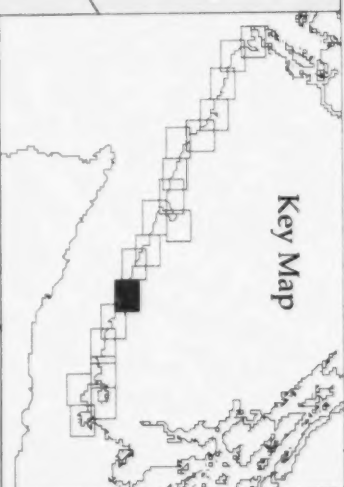
collected materials may be possible.

From French Beach west to Point No Point, there is a sequence of small sand / pebble pocket beaches and rocky outcroppings. Many areas toward the point are backed by low cliffs which would make equipment deployment impossible, and marine-based operations difficult, even in relatively calm conditions. Cleanup would often be impractical in this sector.

No Name Beach and Beach House Beach have a high level of public use and will require extensive manual cleaning. West Beach, and Tailings Beach to the west, could also be cleaned. Water flushing of oil could be tried, with subsequent booming and skimming during favourable sea conditions. Relocating oil to the surf zone could provide an alternative cleanup technique.

The rocky headlands in the vicinity of Rockbottom Creek present a relatively lower cleanup priority since oil would not likely persist there.

Operational Map 7 Tailings Beach to Fatt Creek Shoreline Sensitivity



SHORELINE SENSITIVITY

Operational Map 7 - Tailings Beach to Fatt Creek

Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Sensitivity Ranking
21	E Jordan River	25.1
22	Jordan R. estuary/China Beach	40.3
23	San Simon Point	16.6

	Community C		Many Birds B
	Commercial Fisheries CF		Harbour Seal HS
	Tourism T		Orca Or
	Industry I		Grey Whale GW
	Recreation Local RL		Salmonid Spawning Sa
	Recreation Diffuse RD		Kelp Beds K
	Intertidal Harvesting SH		Heritage Site High H
	Offshore Harvesting SH		
	Bird Colony BC		

C 22 Jordan River.

CF 21-23 An average of 2 commercial fishing boats per day fish for rockfish from Race Rocks to Bonilla Point in the months of May to November. From July to mid-September, an average of 30 commercial fishing boats per day fish for all 5 species of salmon in the area from Sheringham Point to Port San Juan. Sockeye and Pink salmon are the most common catches.

T 22 Two restaurants are located on the west bank of the Jordan River.

I 22 Western Forest Products Limited have a dry land log sorting area and log booming area north of the bridge on the Jordan River.

RL 21 Sandcut Beach, which is maintained by WFPL, is accessed by a trail that takes 5 minutes to walk.

RL 22 An average of 2 boats per day fish for all 5 species of salmon from June to September around the mouth of the Jordan River and an average of 4 boats per day fish for halibut from June to September in the same area. Surfing and windsurfing occur at the mouth of the Jordan River where the Western Forest Products Limited picnic site is also located. There are public boat ramps on the east and west side of the Jordan River. China Beach has a picnic site and a beach that is used in the summer months.

RL 23 Mystic Beach, which is located west of San Simon Point, is used in the summer months and is accessed by a 5-minute long walk from the highway. The beach is maintained by Western Forest Products Limited.

RD 21-23 Mussels and Goose-neck barnacles are occasionally harvested from Otter Point to Bonilla Point. From May to November, an average of 5 boats per day fish for Lingcod in the area from Otter Point to Bonilla Point.

RD 21-22 There is hiking along the beach from Sandcut Creek to China Beach and within China Beach Provincial Park.

SH 21-22 Both offshore and intertidal native subsistence harvesting occur in these areas.

SH 23 Offshore native subsistence harvesting occurs in this area.

BC 23 A colony of Pelagic cormorants (24 birds) occurs off San Simon Point.

B 22 Gulls congregate on the beaches in this area, particularly around the mouth of the Jordan River in the summer

and fall.

HS 23 A few Harbour seals have been observed hauled out at San Simon Point.

Or 21-23 Transient pods of orcas may be found along the coast throughout the year.

GW 21,23 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

GW 22 Grey whales have been sighted fairly regularly off Jordan River. They are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

Sa 22 The Jordan River supports runs of 4 salmon species distributed in the following numbers:

Species	Maximum Recorded Escapement
Chum	750
Coho	200
Steelhead	25
Pink	7,500

Maidenhair and Uglow Creeks have occasional runs of Coho salmon, maximum recorded escapements are 9 and 7 fish respectively.

K 21-23 Kelp beds occupy the coastline in these areas.

H 22 Sensitive. This unit contains Heritage Site #100.

SS 21 A short 5-minute walk to Sandcut Beach is maintained by Western Forest Products Limited.

SS 22 The Jordan River picnic site located at the mouth of the Jordan River is maintained by Western Forest Products Limited. It has a parking lot that can accommodate campers and trailers.

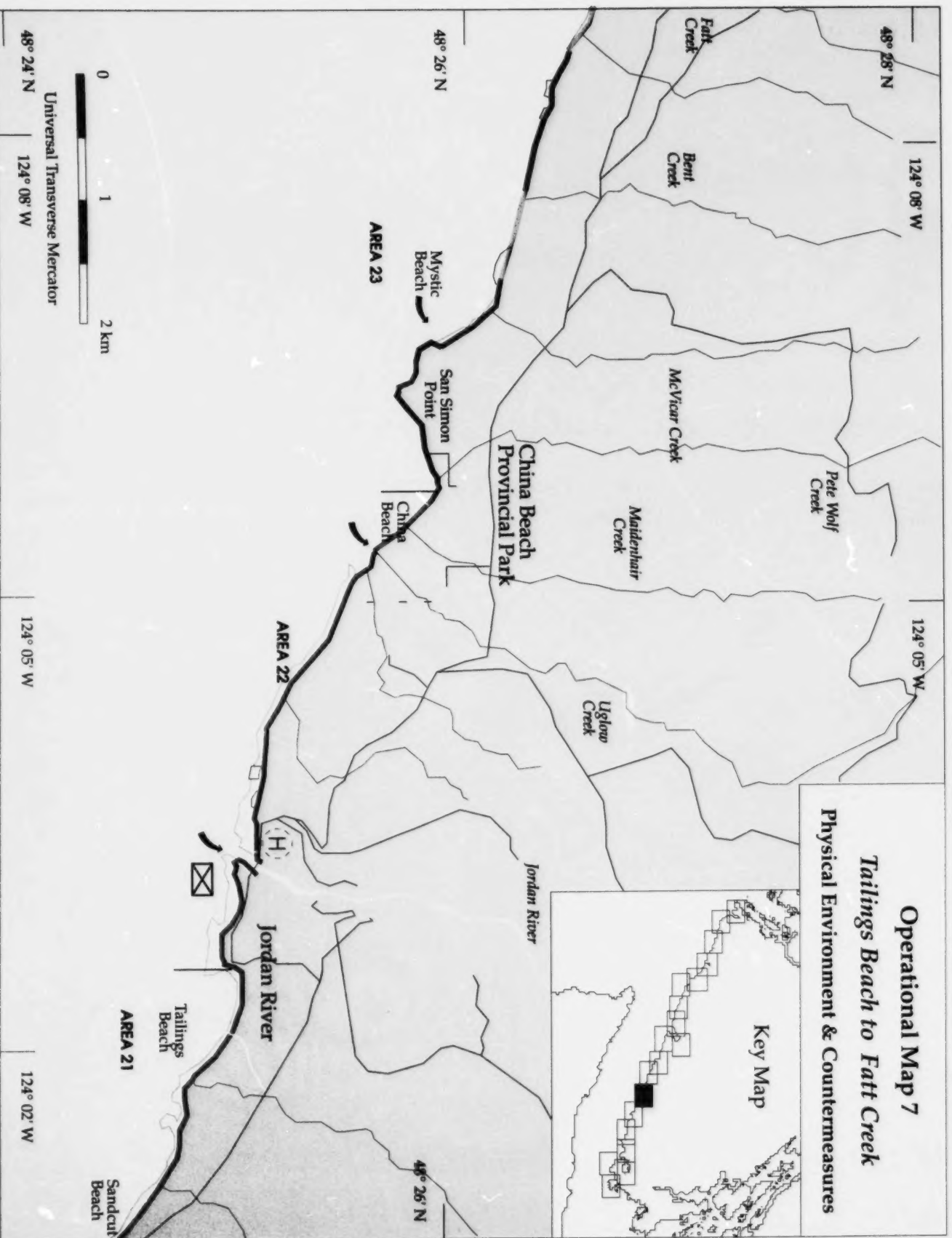
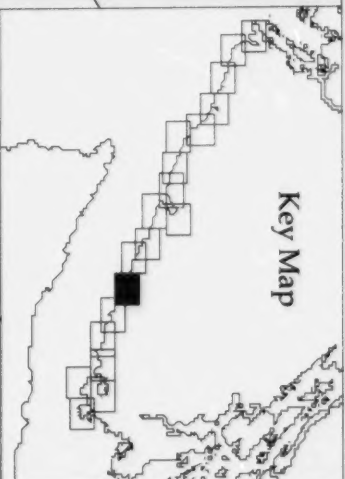
SS 22-23 China Beach Provincial Park is located to the west of River Jordan.

SS 23 Mystic Beach, which is maintained by Western Forest Products Limited, is located west of San Simon Point.



Operational Map 7 Tailings Beach to Fatt Creek Physical Environment & Countermeasures

Key Map



Universal Transverse Mercator

PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 7- *Tailings Beach to Fatt Creek*

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

The shoreline in this area can be reached from Highway 14 at Jordan River. The townsite could accommodate the staging of equipment for transport by land, sea, and helicopter.

China Beach (normally reached by trail) is accessible through rough terrain from Jordan River at low tide. Vessel landings in this area are dependent on waves; surf conditions are common.

The area from San Simon Point to Fatt Creek has no surface connection (Highway 14 is set back from the coast). Low cliffs prevent trails to the shoreline in many locations. One exception is a trail which leads to Mystic Beach. Approaches from the sea are often curtailed by high waves and a lack of beaches along this section of coast.

COUNTERMEASURES

Booming and skimming may be possible at the mouth of the Jordan River (except in conditions of surf and breaking waves). Protection booming could also be implemented using approximately 100 m of river boom. The outflowing river is expected to prevent oil from intruding upstream beyond the bridge into the log storage area.

The shoreline and associated parkland at Jordan River is composed of wide expanses of a coarse pebble/boulder veneer over sand. The beaches in this area have high recreational and local value. Adjoining beaches contain similar mixtures of sand/pebble/cobble materials, and have a relatively low slope with moderate-to-high wave energy. Oil could be flushed with water and collected in booms nearshore (sea conditions allowing). Manual clean-up methods may have to be used over mechanical means for oil removal because of the presence of larger cobble materials.

At China Beach, stretches of sand are interrupted by patches of cobble, pebble and boulders. Mechanical removal of oil would be possible for some sectors, while flushing and oil collection would have to be pursued for others. A high level of cleanup will be required for this popular beach.

To the west, there is a repetitive sequence of boulders and cliffs which are sometimes characterized by a narrow band of coarse sediments. This area has a much lower cleanup priority, and response options are limited by transport problems along much of the shore. An exception is Mystic Beach where the sand and cobble is relatively protected and could be cleaned using manual or mechanical methods.

The small pocket beach associated with San Simon Point (a nesting area for Pelagic cormorants and various seagulls) is another possibility where resources could be landed. The cliffs around the Point would clean naturally in the high wave conditions. The intertidal rock shelves are biologically productive and immediate oil removal might be necessary.

Loss Creek
Provincial Park

124° 15' W

Loss Creek

Limes
Creek

Hoard
Creek

AREA 25

Magdalena Point

Clinch
Creek

Rosemond
Creek

AREA 24

AREA 23

Fatt
Creek

Juan de Fuca Strait

48° 26' N

0 1 2 km

Universal Transverse Mercator

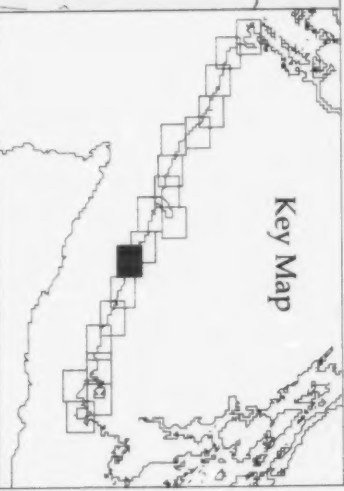
124° 15' W

Operational Map 8

Fatt Creek to Loss Creek

Shoreline Sensitivity

Key Map



48° 28' N

AREA 26

48° 26' N

124° 10' W

SHORELINE SENSITIVITY

Operational Map 8 - Fatt Creek to Loss Creek

Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

*See Appendix A

No.	Name	Area	Sensitivity Ranking
23	San Simon Point		16.6
24	Clinch Creek		10.9
25	Magdalena Point		9.5
26	Loss Creek		12.2

	Commercial Fisheries CF		Orca Or
	Recreation Diffuse RD		Grey Whale GW
	Offshore SH		Kelp Beds K

CF 24-26 An average of 2 commercial fishing boats per day fish for rockfish from Race Rocks to Bonilla Point in the months of May to November. From July to mid-September, an average of 30 commercial fishing boats per day fish for all 5 species of salmon in the area from Sheringham Point to Port San Juan. Sockeye and Pink salmon are the most common catches.

RD 23-26 Mussels and Goose-neck barnacles are occasionally harvested from Otter Point to Bonilla Point. From May to November, an average of 5 boats per day fish for Lingcod in the area from Otter Point to Bonilla Point.

SH 23-26 Offshore native subsistence harvesting occurs in these areas.

Or 23-26 Transient pods of orcas may be found along the coast throughout the year.

GW 23-26 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

K 23,25,26 Kelp beds occur sporadically along this section of coast.

K 24 A higher density of kelp occurs at the mouth of Rosemond Creek.

Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

Seasonal Durations of Biological Activity and Resource Use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

CF 24 - 26
RD 23 - 26
GW 23 - 26

Note: All other items not shown are present throughout the year.

Loss Creek
Provincial Park

124° 15' W

Loss Creek

AREA 26

48° 28' N

Limes
Creek

AREA 25

Haard
Creek

Magdalena Point

AREA 24

Clinch
Creek

Rosemond
Creek

AREA 23

Fatt
Creek

Operational Map 8
Fatt Creek to Loss Creek
Physical Environment & Countermeasures

Key Map

Juan de Fuca Strait

48° 26' N

0 1 2 km

Universal Transverse Mercator

124° 15' W

124° 10' W

48° 26' N

PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 8 - *Fatt Creek to Loss Creek*

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

There are no roads in this area.

Marine travel and landings are dependent upon wave conditions and the configuration of nearshore bedrock platforms. Platforms around Magdalena Point create a particularly hazardous environment. In the eastern section, low backcliffs create areas where workers could be trapped by a rising tide.

Loss Creek is potentially the most suitable helicopter landing site.

Clinch Creek (below the correctional institute) features a slightly wider coarse sediment beach which may be more suited to mechanical and/or manual cleanup techniques.

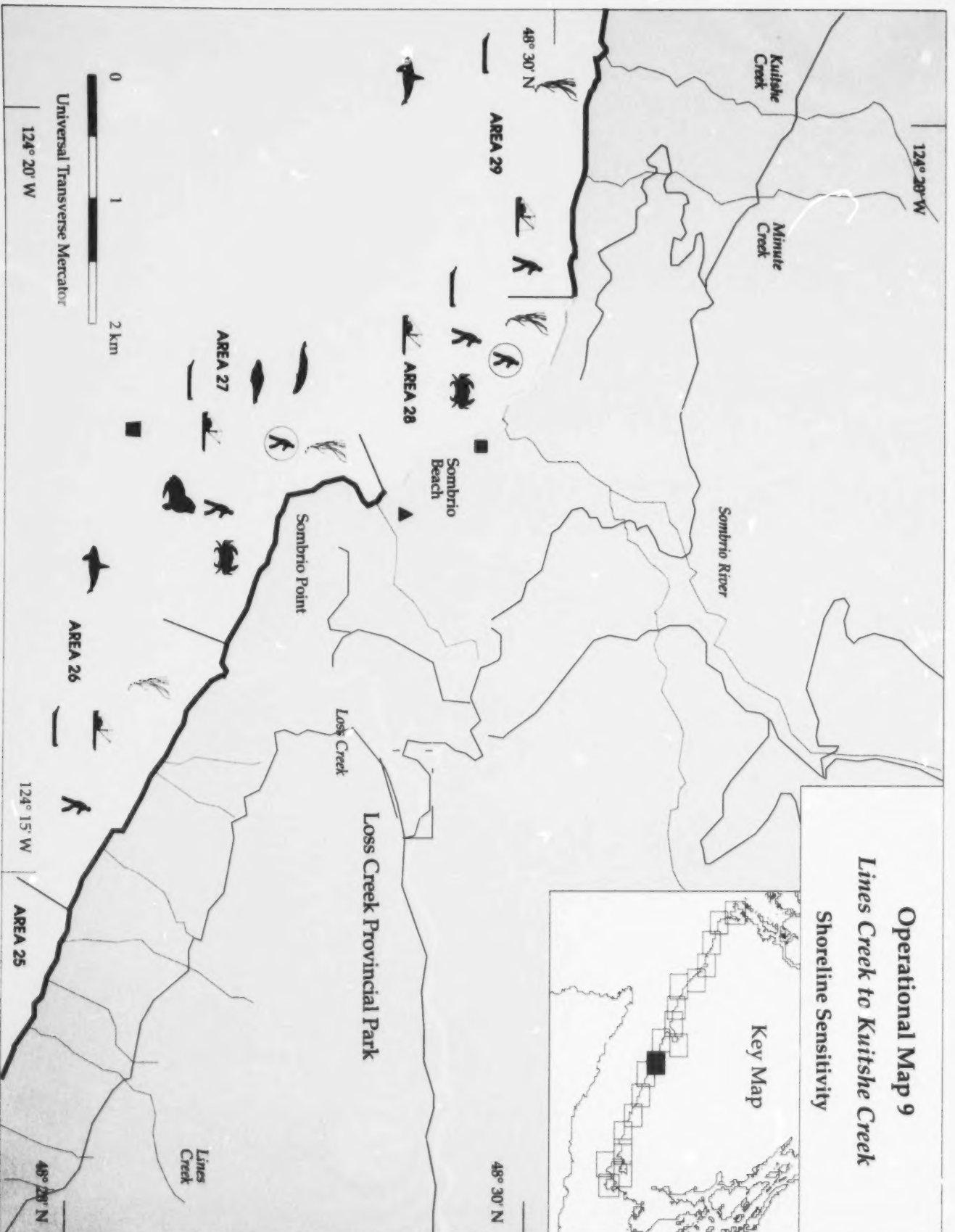
COUNTERMEASURES

This section is characterized by low cliffs fronted by bedrock platforms which are frequently covered by cobble/boulders. A continuous narrow beach consisting of coarse sediments runs along the foot of the cliffs. The shoreline composition combined with the lack of access by either land or sea, will make cleanup operations extremely difficult in this area. The relatively high waves in this sector can be expected to naturally remove significant amounts of oil over time.

It is questionable as to whether or not low pressure flushing of platforms could be safely initiated at low tide because of overwashing waves and possible entrapment of personnel at high tide. Rapid re-oiling of the rocky outcroppings could occur as free-floating oil is moved along the shore.

At Loss Creek further to the west, landing from the water or by air might be possible to effect a localized manual cleanup of the coarse sediments at the creek mouth.

Operational Map 9 Lines Creek to Kuitshe Creek Shoreline Sensitivity



Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Sensitivity Ranking
25	Magdalena Point	9.5
26	Loss Creek	12.2
27	Sombrio Point	16.3
28	Sombrio Beach	21.6
29	Kuitshe Creek	9.8

	Commercial Fisheries CF		Sea Lion SL
	Recreation Local RL		Orca Or
	Recreation Diffuse RD		Grey Whale CW
	Intertidal Harvesting SH		Shellfish Sh
	Offshore Harvesting SH		Kelp Beds K
	Harbour Seal HS		Heritage Site High H
			Heritage Site Moderate H

CF 26-29 An average of 2 commercial fishing boats per day fish for rockfish from Race Rocks to Bonilla Point in the months of May to November. From July to mid-September, an average of 30 commercial fishing boats per day fish for all 5 species of salmon in the area from Sheringham Point to Port San Juan. Sockeye and Pink salmon are the most common catches.

CF 27-29 Sea urchins are commercially harvested in the area east of Sombrio Point to the west of the mouth of the Sombrio River.

RL 27 An average of 2 boats per day fish for all 5 species of salmon and halibut from June to September around Sombrio Point. An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds around Sombrio Point. There is a hiking trail from the beach to Loss Creek Provincial Park. Surfers use the area around Sombrio Point occasionally.

RL 28 Sombrio Beach is located at the mouth of the Sombrio River and is used in the summer months. The short trails leading to the beach are maintained by Western Forest Products Limited. Surfers occasionally use this area.

RD 26-29 Mussels and Gooseneck barnacles are occasionally harvested from Otter Point to Bonilla Point. From May to November, an average of 5 boats per day fish for Lingcod in the area from Otter Point to Bonilla Point.

SH 26-29 Offshore native subsistence harvesting occurs in these areas.

SH 27 Intertidal native subsistence harvesting occurs in this area.

HS 27 A Harbour seal haulout (46 animals) is located at Sombrio Point.

SL 27 Steller and California sea lions (93+ in winter; 70 in spring) also haul out at Sombrio Point.

Or 25-29 Transient pods of orcas may be found along the coast throughout the year.

CW 25-26, 28-29 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

GW 27 Grey whales have been sighted fairly regularly off Sombrio Point. They are most frequently sighted during their spring and fall migrations, but may be found at any time between February and December.

Sh 27-28 Urchins are reported occurring in abundance along the coast near Sombrio Point.

K 26-27 Kelp beds occur sporadically along this section of the coast.

K 28-29 Extensive kelp beds occupy the coastline west of Sombrio River.

H 28 Highly sensitive. This unit contains Heritage Sites #101 & 102.

SS 28 Sombrio Beach is located at the mouth of the Sombrio River and is used in the summer months. The short trails leading to the beach are maintained by Western Forest Products Limited.

Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

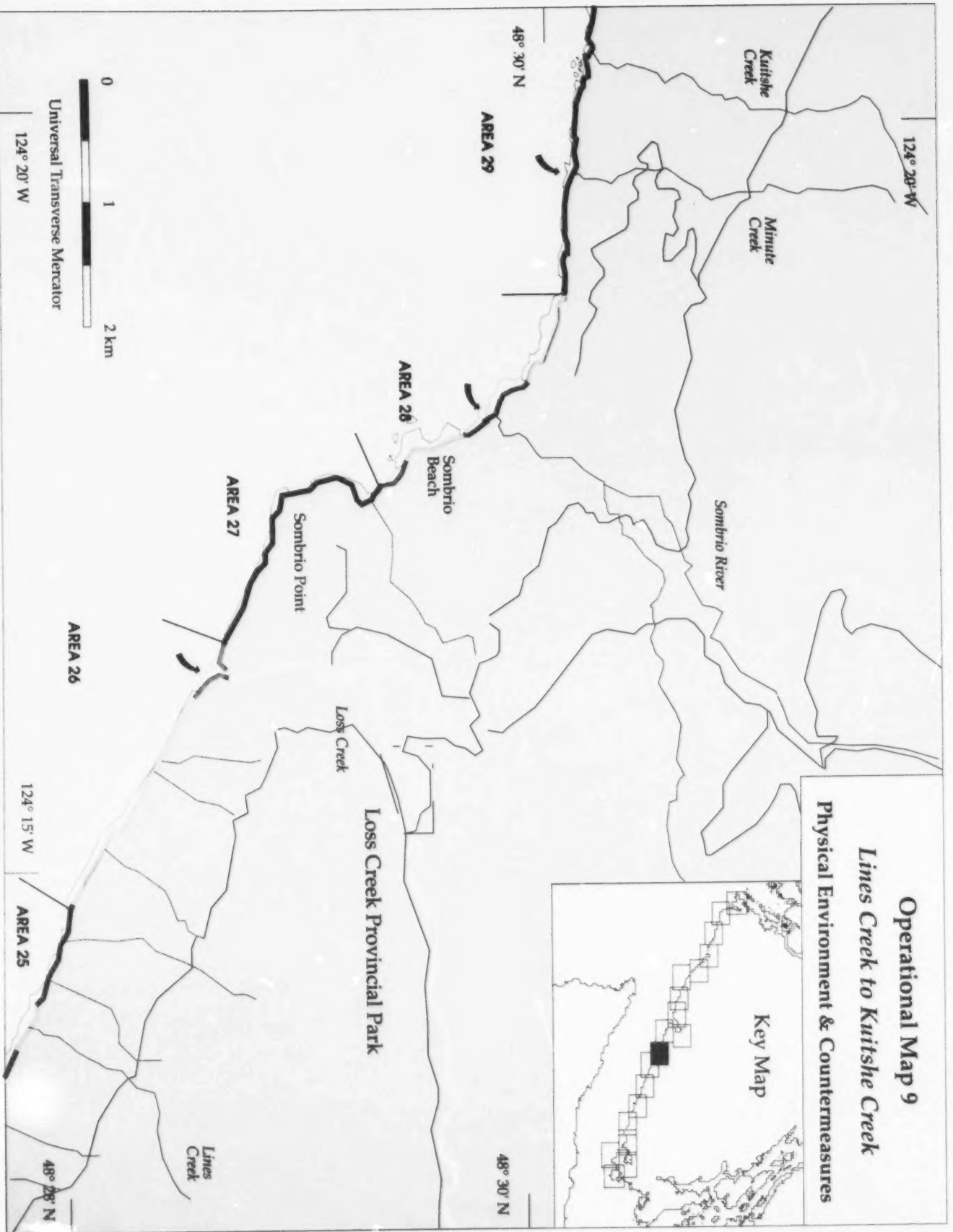
In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

For detailed information about heritage sites, contact the B.C. Ministry of Environment, Environmental Emergency and Coastal Protection Branch or the B.C. Ministry of Municipal Affairs, Recreation and Culture, Heritage Conservation Branch (in Victoria).



Operational Map 9 Lines Creek to Kuitshe Creek

Physical Environment & Countermeasures



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 9 - Lines Creek to Kuitshe Creek

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Rocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

The only roads in this section are old logging roads which are approximately 100 metres from the shoreline in the area near Minute Creek (these roads would likely require clearing). Low backshore cliffs restrict foot passage along-shore.

Marine landings are prohibited by wave-cut platforms along this section of coast. The only possible vessel landing locations are at the mouths of Loss Creek and the Sombrio River where the bedrock is overlain by sediments.

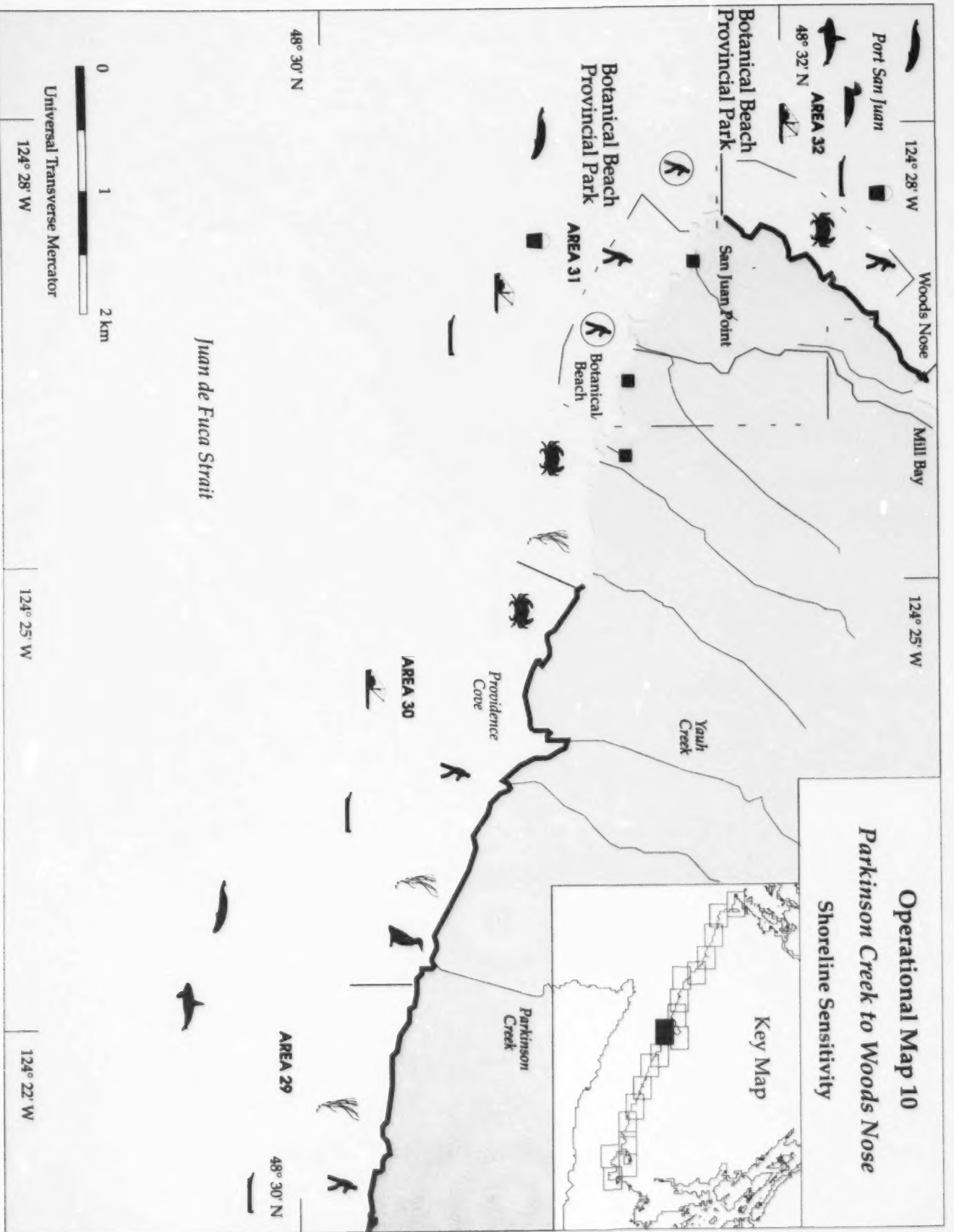
COUNTERMEASURES

Cleanup efforts will be hampered in this sector by the lack of transport. The coastline is generally characterized by nearshore rocks and reefs with steep, narrow bands of bedrock (low oil persistence). Rapid self-cleaning is expected in this high energy environment. The mouth of Kuitshe Creek is a typical example of this type of shoreline.

The mouth of the Sombrio River is characterized by gravel and cobble materials which could be cleaned using water flushing techniques in conjunction with containment and skimming (sea conditions allowing). Landing at the river is possible in calm water. Exclusion booms would not be feasible since the river mouth is not well-defined. The recreational use of this area necessitates a high level of cleanup.

Discontinuous sections of wider beaches in this sector (comprised of cobble and boulder) could be flushed of oil; recovery of this oil is unlikely in the prevailing marine conditions, and re-oiling is expected.

Operational Map 10 **Parkinson Creek to Woods Nose** **Shoreline Sensitivity**



Environmental Description

Legend

- Shoreline Sensitivity***
- Extreme Sensitivity Ranking > 45
 - High Sensitivity Ranking 35-45
 - Moderate Sensitivity Ranking 21-34.9
 - Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Sensitivity Ranking
29	Kulste Creek	9.8
30	Providence Cove	12.4
31	Botanical Beach	26.7
32	E Port San Juan	20.2



CF 29-32 An average of 2 commercial fishing boats per day fish for rockfish from Race Rocks to Bonilla Point in the months of May to November. From July to mid-September, an average of 30 commercial fishing boats per day fish for all 5 species of salmon in the area from Sheringham Point to Port San Juan. Sockeye and Pink salmon are the most common catches.

CF 30-31 Sea urchins are harvested in the vicinity of Botanical Beach.

CF 32 Commercial fishing for crabs occurs throughout Port San Juan.

RL 31 An average of 5 boats per day fish for all 5 species of salmon from June to September around San Juan Point. Botanical Beach is used in the summer months.

RD 29-32 Mussels and Gooseneck barnacles are occasionally harvested from Otter Point to Bonilla Point. From May to November, an average of 5 boats per day fish for Lingcod in the area from Otter Point to Bonilla Point.

RD 31-32 An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds from San Juan Point to Bonilla Point. Botanical Beach Provincial Park provides marine life viewing along the shoreline and hiking trails back to Port Renfrew.

RD 32 An average of 5 boats per day fish for all 5 species of salmon from June to September in Port San Juan. An average of 60 crab traps (Dungeness and Red Rock) are set from June to September in the Port San Juan area.

SH 29-32 Offshore native subsistence harvesting occurs in these areas.

SH 31,32 Intertidal native subsistence harvesting occurs in these areas.

BC 30 A colony of Pelagic cormorants (15 pairs) occurs off Parkinson Creek.

MB 32 Moulting concentrations of White-winged scoters (approx. 40) occur along the eastern shorelines of Port San Juan.

Or 29-32 Transient pods of orcas may be found along the coast throughout the year. They are frequently sighted at the entrance to Port San Juan.

CW 29-31 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

CW 32 Grey whales have been recorded feeding off the

bottom in Port San Juan bay. They may be found at any time between February and December.

Sh 31 The extensive tidepools around Botanical Beach and the mouth of the Sombro River (area 28) are prime habitat for a rich variety of other invertebrates.

Sh 32 Crab are fished in this area. Squid spawn in the area. K 29-31 Kelp occurs in moderate to high densities along most of the coast east of San Juan Point.

H 31 Highly sensitive. This unit contains Heritage Sites #103 - 105.

SS 31,32 Botanical Beach Provincial Park.

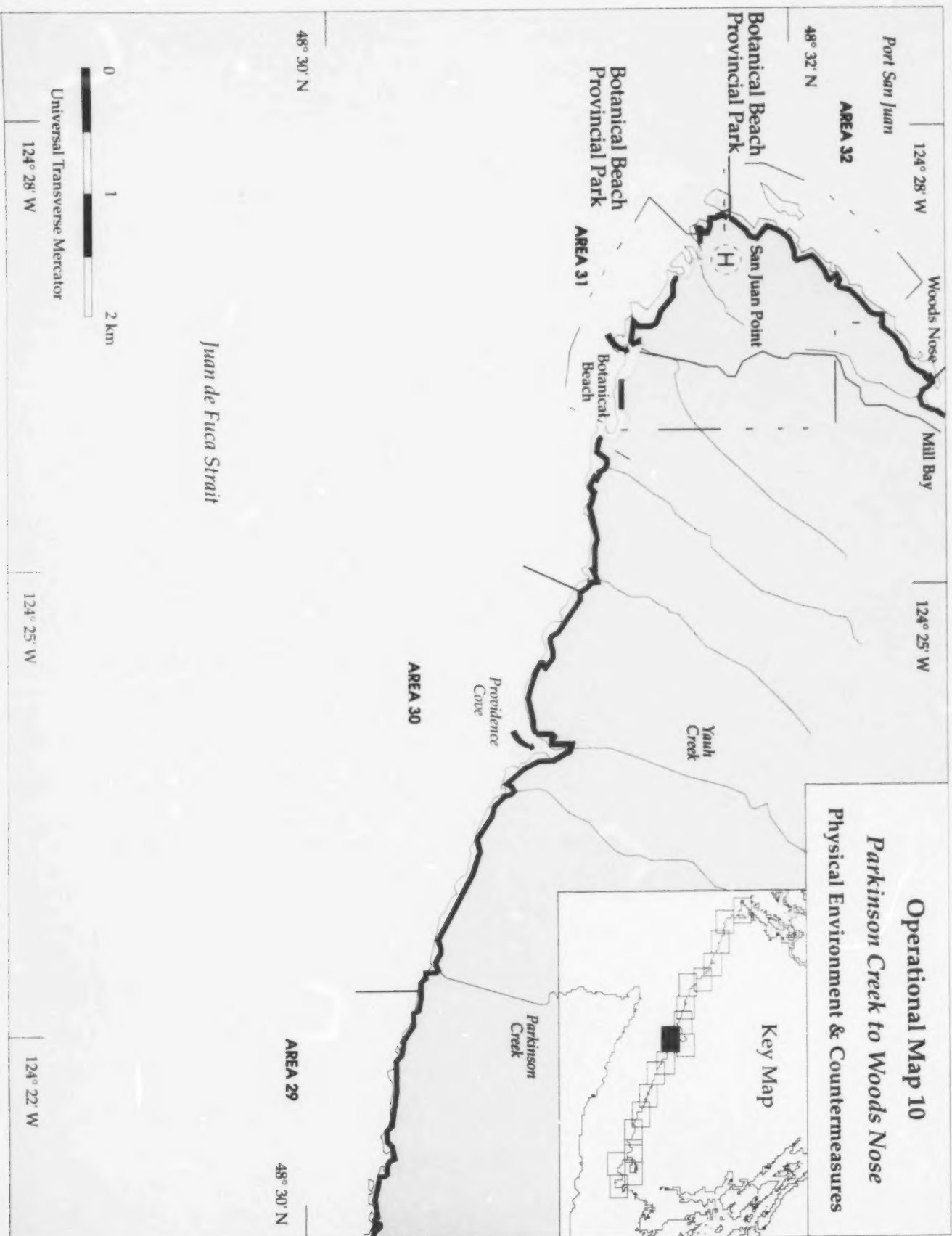
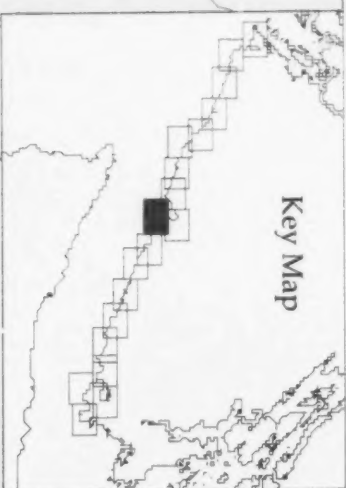
Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

For detailed information about heritage sites, contact the B.C. Ministry of Environment, Environmental Emergency and Coastal Protection Branch or the B.C. Ministry of Municipal Affairs, Recreation and Culture, Heritage Conservation Branch (in Victoria).



Operational Map 10 **Parkinson Creek to Woods Nose** **Physical Environment & Countermeasures**



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 10 - *Parkinson Creek to Woods Nose*

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

A narrow gravel road ending within 50-100 m of Botanical Beach forms the only surface connection along this section (Highway 14 is far inland). Rock platforms backed by back-shore cliffs restrict shoreline travel to low tide.

High waves and surf, along with an almost continuous bedrock platform, prevent vessel landings, except at Providence Cove which has the only sheltered beach.

Helicopter landings are possible at San Juan Point.

COUNTERMEASURES

The western portion of this sector is dominated by low cliffs fronted by sloping platforms of intrusive rock. There is no veneer of beach; natural weathering of oil and removal by wave action are likely to be more effective than manual methods.

Providence Cove has good access from the sea during favourable weather conditions. Water flushing of the coarse, mixed sediment beach would then be possible, followed by containment and skimming of removed oil.

Manual methods may be required to complete the cleanup.

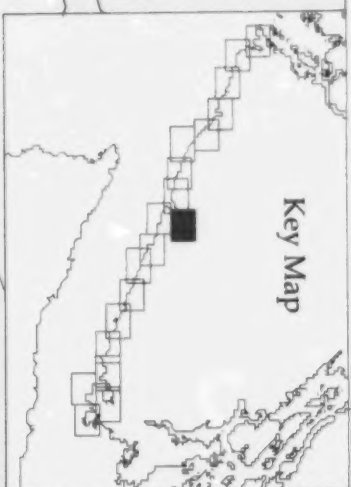
Toward San Juan Point, the coastline continues to be characterized by bedrock outcroppings scarred by surge channels. The bedrock forms a series of platforms exposed to high energy waves. A sporadically distributed, narrow band of coarse sediments in the upper intertidal zone (often with a steep slope) would make cleanup difficult. Cleanup is unlikely in this area; approaches from the marine side are dangerous due to reefs and rocks, and there is no backshore access.

The tidal pools of Botanical Beach are an important tourist attraction and would require carefully supervised manual cleanup.

The finer grained sediments present in the pocket beach near Woods Nose are a likely place for oil to accumulate. Flushing, booming and skimming could be tried; a this more sheltered area. Alternatively, mechanical methods to remove stranded oil could be considered.

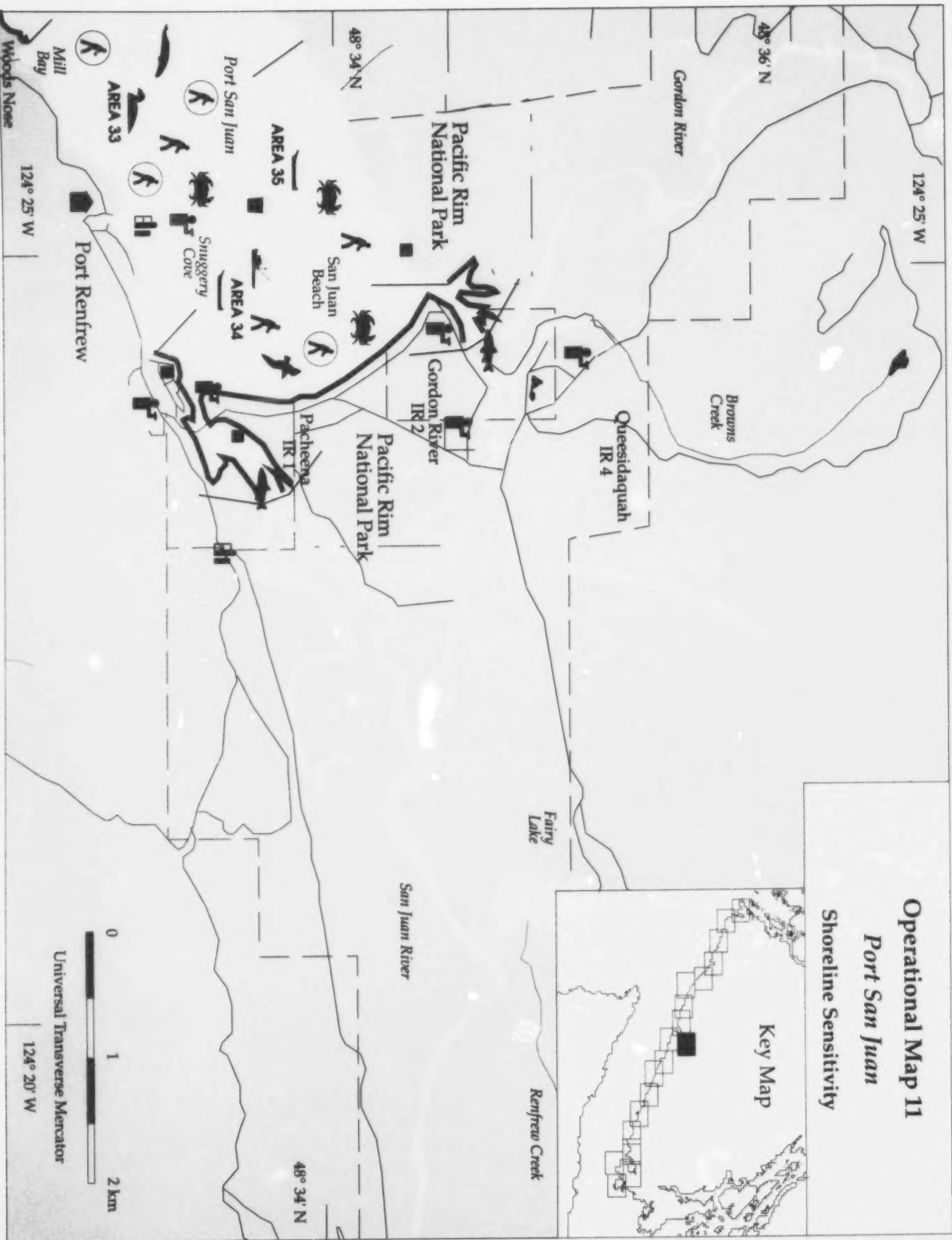
Marine operations could be attempted towards the entrance of Port San Juan using booms and skimmers. Response priorities in this area are driven by the need to minimize potential impacts to significant populations of waterfowl and seals inhabiting nearshore rocks.

Operational Map 11 Port San Juan Shoreline Sensitivity



Fairy Lake

Renfrew Creek



Environmental Description

Legend

- Shoreline Sensitivity***
- Extreme Sensitivity Ranking > 45
 - High Sensitivity Ranking 35-45
 - Moderate Sensitivity Ranking 21-34.9
 - Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Sensitivity Ranking
33	E Port San Juan	24.2
34	Gordon/San Juan Rivers	52.5
35	W Port San Juan	30.3

	Community C		Many Birds B
	Commercial Fisheries CF		Mouling Birds MB
	Tourism T		Grey Whale CW
	Industry I		Salmonid Spawning Sa
	Recreation Local RL		Shellfish Sh
	Recreation Diffuse RD		Kelp Beds K
	Intertidal Harvesting SH		Heritage Site Moderate H
	Offshore Harvesting SH		

C 33,34 Port Renfrew.

C 34 The Pachenaht Indian Band have homes at the mouth of the Gordon and San Juan Rivers.

CF 33-35 Commercial fishing for squid and crab occurs throughout Port San Juan. An average of 2 commercial fishing boats per day fish for rockfish from Race Rocks to Bonilla Point in the months of May to November. From July to mid-September, an average of 30 commercial fishing boats per day fish for all 5 species of salmon in the area from Sherningham Point to Port San Juan. Sockeye and Pink salmon are the most common catches.

T 33 There are guided ocean kayak tours from Port Renfrew to destinations along the West Coast Trail. Fishing charter companies based out of Port Renfrew fish the Port San Juan areas and points in the Strait of Juan de Fuca throughout the year. These charter services also provide ferry services to the start of the West Coast Trail. The Port Renfrew Hotel is located at Port Renfrew.

T 34 The Pachenaht Band have trailer and tenting sites at the mouth of the Gordon River and San Juan River. They also have a ferry service for hikers starting or finishing the West Coast Trail and 2 boat launching sites. Pacific Rim Charters and Elliot Ferry Service ferry hikers to the West Coast Trail. Gallagher's West Coast Fish Camp, which is located upriver of the mouth of the Gordon River, has cabin rentals. Port Renfrew Marina and RV Park, which is located at the mouth of Browns Creek, provides picnic sites, recreational vehicle sites, and tour guides for the West Coast Trail. Sea kayak tours are based at the mouth of the San Juan River. The Beachview Bed and Breakfast house is located at the mouth of the San Juan River.

I 33 Commercial and recreational fishermen use the government wharf at Port Renfrew. The San Juan Fishing Company has a fish processing plant at the government wharf (mainly fish icing) which is used from June to September.

I 34 Port Renfrew Cedar Products is located east of the mouth of the San Juan River. The logs are transported to the mill by trucks.

RL 33 Clams are occasionally harvested from the beach at Port Renfrew when the area is not subject to a closure. More than one fisherman per day fishes for squid at the government wharf from June to September. There is a public boat launch at Port Renfrew operated by B.C. Forest

Products Ltd. The beach at Mill Bay, which is south of Port Renfrew, is used in the summer months.

RL 34 An estimated half dozen windsurfers and surfers use the area between the San Juan River and the Gordon River. San Juan Beach is used in the summer months. An average of 5 fishermen with nets fish for smelt on the north beach of Port San Juan from June to September.

RD 33-35 Mussels and Gooseneck barnacles are occasionally harvested from Otter Point to Bonilla Point. From May to November, an average of 5 boats per day fish for Lingcod in the area from Otter Point to Bonilla Point. An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds from San Juan Point to Bonilla Point. An average of 5 boats per day fish for all 5 species of salmon from June to September in Port San Juan. An average of 60 crab traps (Dungeness and Red Rock) are set from June to September in the Port San Juan area. There is good anchorage for sailing vessels along the east and north sides of Port San Juan.

RD 33, 34 Windsurfers and kayakers use the Port San Juan area.

RD 34 There is extensive wildlife viewing in the lower San Juan River estuary.

RD 35 Hikers use the West Coast Trail which is not along the water in this area. Divers and kayakers use this area.

SH 34 Intertidal native subsistence harvesting occurs in this area.

SH 33-35 Offshore native subsistence harvesting occurs in this area.

B 34 Gulls collect in high numbers in winter along the beach between the Gordon and San Juan Rivers. The estuaries of the San Juan and Gordon River are another biological highlight of the study region. Swans, geese and dabbling ducks collect in abundance in winter.

MB 33 Moulting concentrations of White-winged scoters (approx. 40) occur on the eastern shores of Port San Juan. CW 33-35 Grey whales have been recorded feeding off the bottom in Port San Juan. They may be found at any time between February and December.

Sa 34 Both rivers and tributaries to the Gordon and San Juan Rivers support runs of 6 salmonid species distributed in the following numbers:



Maximum Recorded Escapement						
Stream	Chum	Coho	Chinook	Sockeye	Pink	Steelhead
Port San Juan	7,500	75,000	7,500	3,500	1,500	750
Gordon	3,500	7,500	3,500	-	1,500	3,500
Renfrew Creek	150	300	200	-	-	-
Harris Creek	-	11,500	1,000	-	-	-

H 34 Sensitive. This unit contains Heritage Sites #106 & 107.
H 35 Sensitive. This unit contains Heritage Site #108.
SS 34 The Gordon River, Pachena, and Quesiadquah Indian Reserves are located in this area.
SS 35 The Quesiadquah Indian Reserve is located in this area.

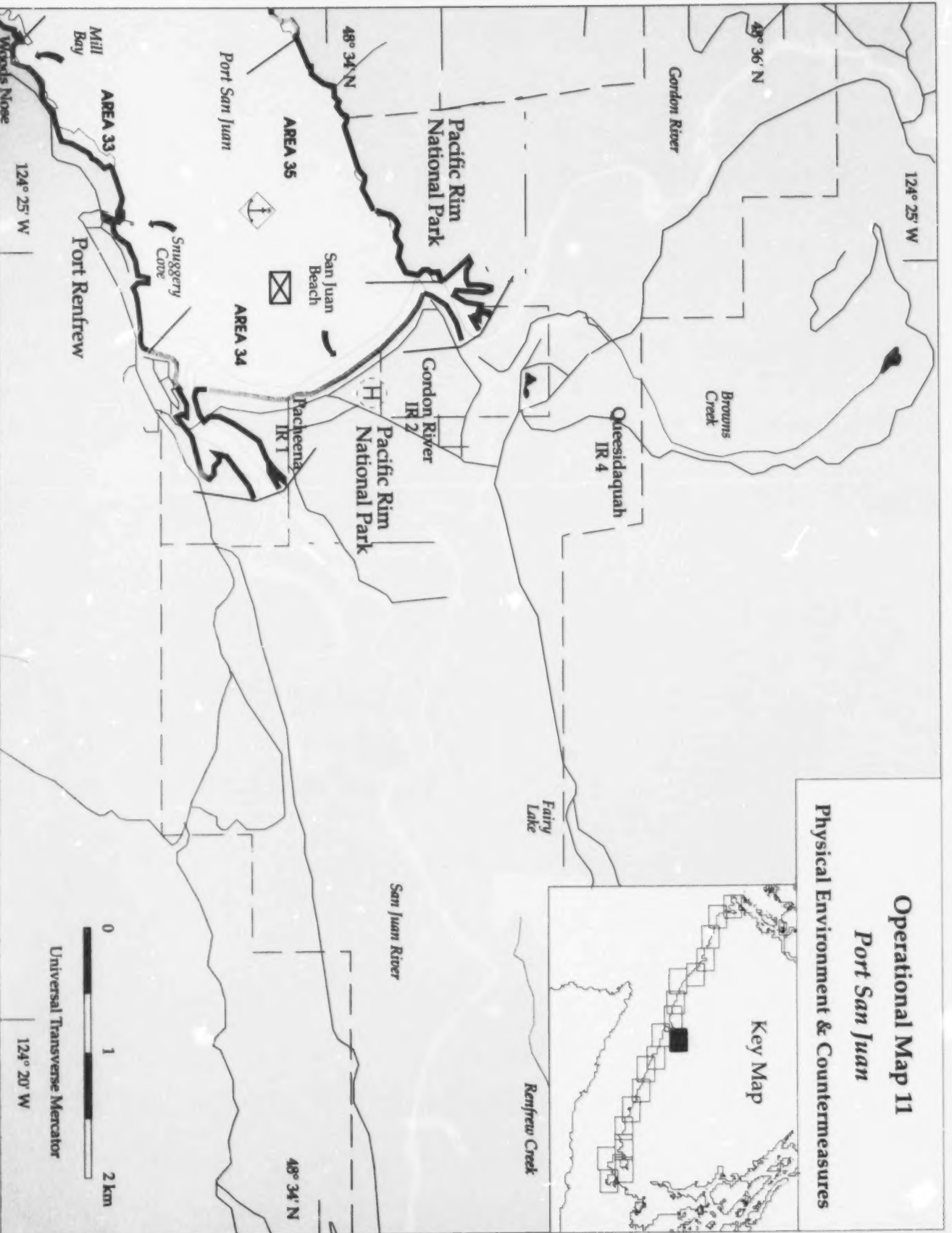
SS 34.35 Pacific Rim National Park. Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

For detailed information about heritage sites, contact the B.C. Ministry of Environment, Environmental Emergency and Coastal Protection Branch or the B.C. Ministry of Municipal Affairs, Recreation and Culture, Heritage Conservation Branch (in Victoria).

Note: All other items not shown are present throughout the year.

Operational Map 11 Port San Juan Physical Environment & Countermeasures



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 11 - Port San Juan

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

Highway 14 and local roads service the inner portion of Port San Juan with the exception of the northern area west of Gordon River. There is a direct road link to the beach area at the head of the inlet.

In the southern section, marine approaches are restricted to small pocket beaches at Woods Nose and Snugery Cove, at Port Renfrew. Steep cliffs limit marine approaches in the northern and western sections.

Marine access is excellent at Port Renfrew as well as at Woods Nose. Port Renfrew has the large government wharf capable of handling vessels with up to 5-6 m draft. Vessel landings on the beach are possible under most conditions.

Port Renfrew and the area between the Gordon and San Juan Rivers are suitable for helicopter operations.

Port San Juan could be considered as a staging area for both land and water-based equipment. The bedrock outcroppings that dominate the surrounding coastline could not accommodate an extensive inventory of cleanup gear; manual operations will be necessary.

COUNTERMEASURES

The pocket beach near Woods Nose is a likely place for oil to accumulate. Flushing, booming, and skimming are possible response options. Alternatively, mechanical methods to remove stranded oil could be considered.

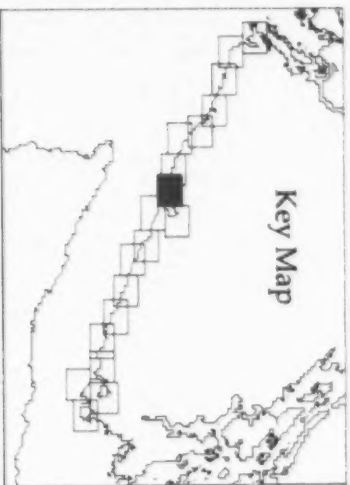
The docks at Port Renfrew will require protection booming to keep slicks from contacting vessels. Small beaches which punctuate the bedrock shoreline in this area constitute a small fraction of the overall shoreline length; in many cases, the beaches are associated with reefs and rocks which would interfere with marine cleanup.

Slicks moving toward the mouth of the San Juan River could be diverted toward the shore. The open reach may make this a low efficiency operation, depending upon time of year, flow in the river, and tidal stage.

At the entrance to the Gordon River, 30 to 60 metres of boom may prevent oil from intruding upon the semi-enclosed area of marsh and sand.

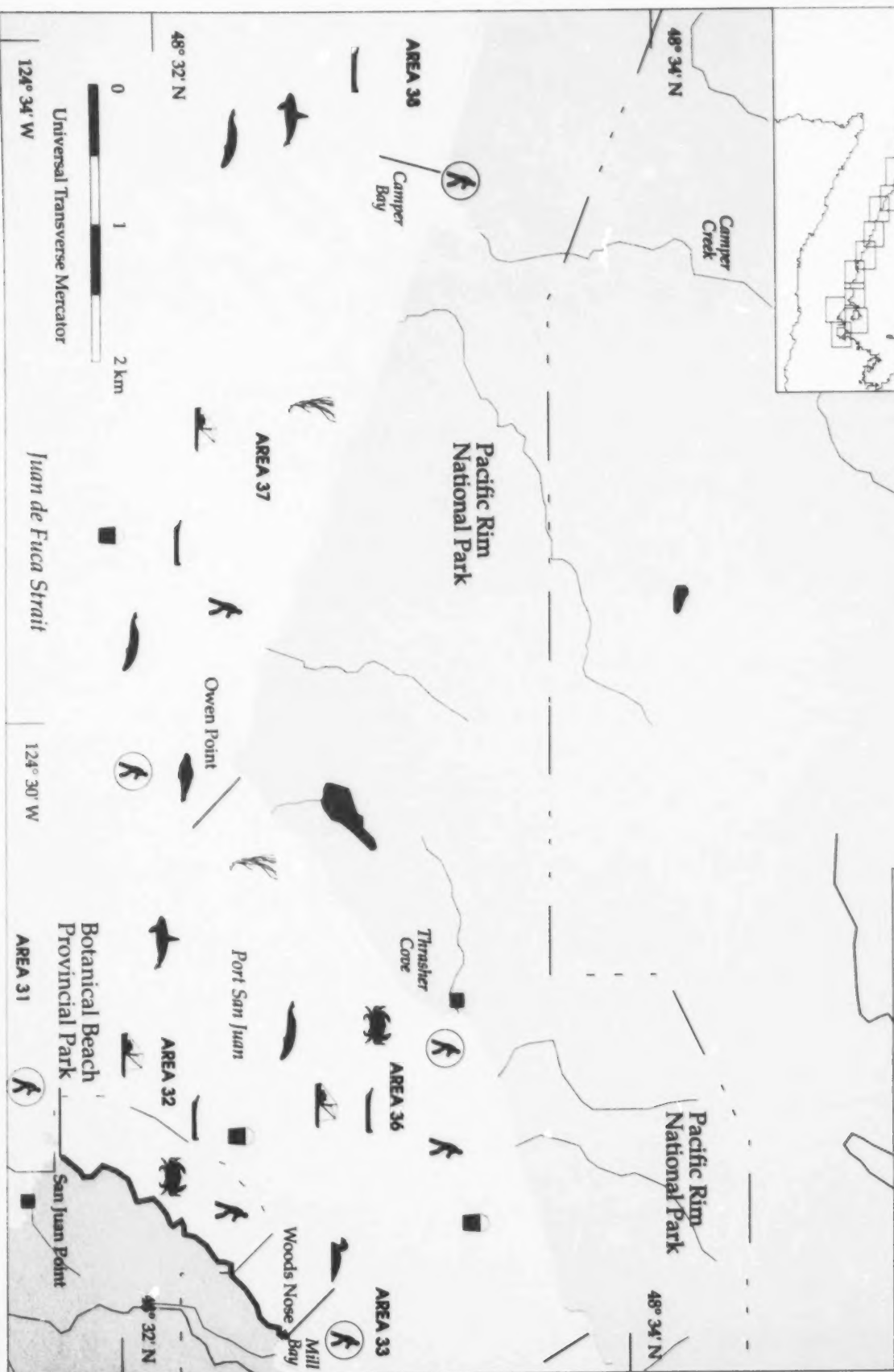
The extensive sand beach between the San Juan and Gordon Rivers can be reached by land and sea; the use of mechanical equipment would be possible in this area. The cliffs to the west would likely receive minimal cleanup attention unless water blasting of oil were attempted (subject to regulatory approval).

Booming and skimming operations in the sheltered waters of Port San Juan could be an effective means of protecting food harvesting. A note of caution concerns the buildup of waves and swells during periods of southwest winds.



124° 30' W

Operational Map 12 Port San Juan to Camper Bay Shoreline Sensitivity



SHORELINE SENSITIVITY

Operational Map 12 - Port San Juan to Camper Bay

Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Sensitivity Ranking
31	Botanical Beach	26.7
32	E Port San Juan	20.2
33	E Port San Juan	24.2
34	Gordon/San Juan Rivers	52.5
35	W Port San Juan	30.3
36	W Port San Juan	27.1
37	Owen Point	22.2
38	Culite Cove	23.3



CF 32,36 Commercial fishing for crab occurs throughout Port San Juan. An average of 2 commercial fishing boats per day fish for rockfish from Race Rocks to Bonilla Point in the months of May to December. From July to mid-September, an average of 30 commercial fishing boats per day fish for all 5 species of salmon in the area from Sheringham Point to Port San Juan. Sockeye and Pink salmon are the most common catches.

CF 37-38 A maximum of 750 commercial fishing boats per day fish for chum salmon and a maximum of 100 commercial fishing boats per day fish for the other species of salmon from mid-September to mid-November in the area from Port San Juan to Cape Beale. An average of 1-2 crab boats per day set traps throughout the year in the area from Port San Juan to Cape Beale.

RL 31 An average of 5 boats per day fish for all 5 species of salmon from June to September around San Juan Point.

Botanical Beach is used in the summer months.

RL 33 The beach at Mill Bay, which is south of Port Renfrew, is used in the summer months.

RL 36 A campsite for the West Coast Trail is located at Thrasher Cove.

RL 37 A campsite for the West Coast Trail is located at Camper Bay. Large sailboats have used Camper Bay for moorage.

RD 32,36-37 Mussels and Gooseneck barnacles are occasionally harvested from Otter Point to Bonilla Point. From May to November, an average of 5 boats per day fish for Lingcod in the area from Otter Point to Bonilla Point. An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds from San Juan Point to Bonilla Point.

RD 32,36 An average of 5 boats per day fish for all 5 species of salmon from June to September in Port San Juan. An average of 60 crab traps (Dungeness and Red Rock) are set from June to September in the Port San Juan area.

RD 32 Botanical Beach Provincial Park provides marine life viewing along the shoreline.

RD 36-37 Hikers use the West Coast Trail (not along the water in this area); kayakers and divers use the marine area along the coast.

RD 37 An average of 70 boats per day fish for all 5 species of salmon from June to September from Owen Point to

Bonilla Point.

SH 32,36-37 Both intertidal and offshore native subsistence harvesting occur in these areas.

SH 38 Offshore subsistence harvesting occurs in this area. MB 32-33 Moulting concentrations of White-winged scoters (approx. 40) occur on the eastern shores of Port San Juan.

HS 37 There is a Harbour seal haulout (34 animals) off Owen Point.

Or 31,32,36-38 Transient pods of orcas may be found along the coast throughout the year. They have been frequently sighted at the entrance to Port San Juan.

GW 32,33,36 Grey whales have been recorded feeding off the bottom in Port San Juan. They may be found at any time between February and December.

GW 31,37,38 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

Sh 32,36 Crab are fished in these areas.

H 31 Highly sensitive. This unit contains Heritage Site #105.

H 36 Sensitive. This unit contains Heritage Site #109.

SS 31,32 Botanical Beach Provincial Park.

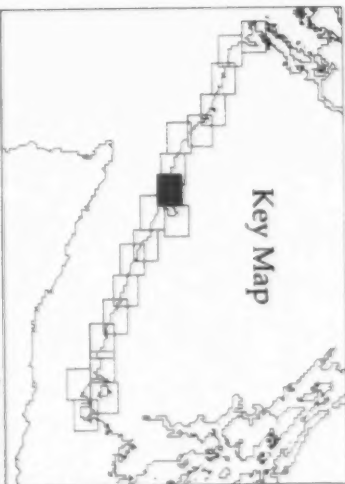
SS 36-38 Pacific Rim National Park.

Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

For detailed information about heritage sites, contact the B.C. Ministry of Environment, Environmental Emergency and Coastal Protection Branch or the B.C. Ministry of Municipal Affairs, Recreation and Culture, Heritage Conservation Branch (in Victoria).

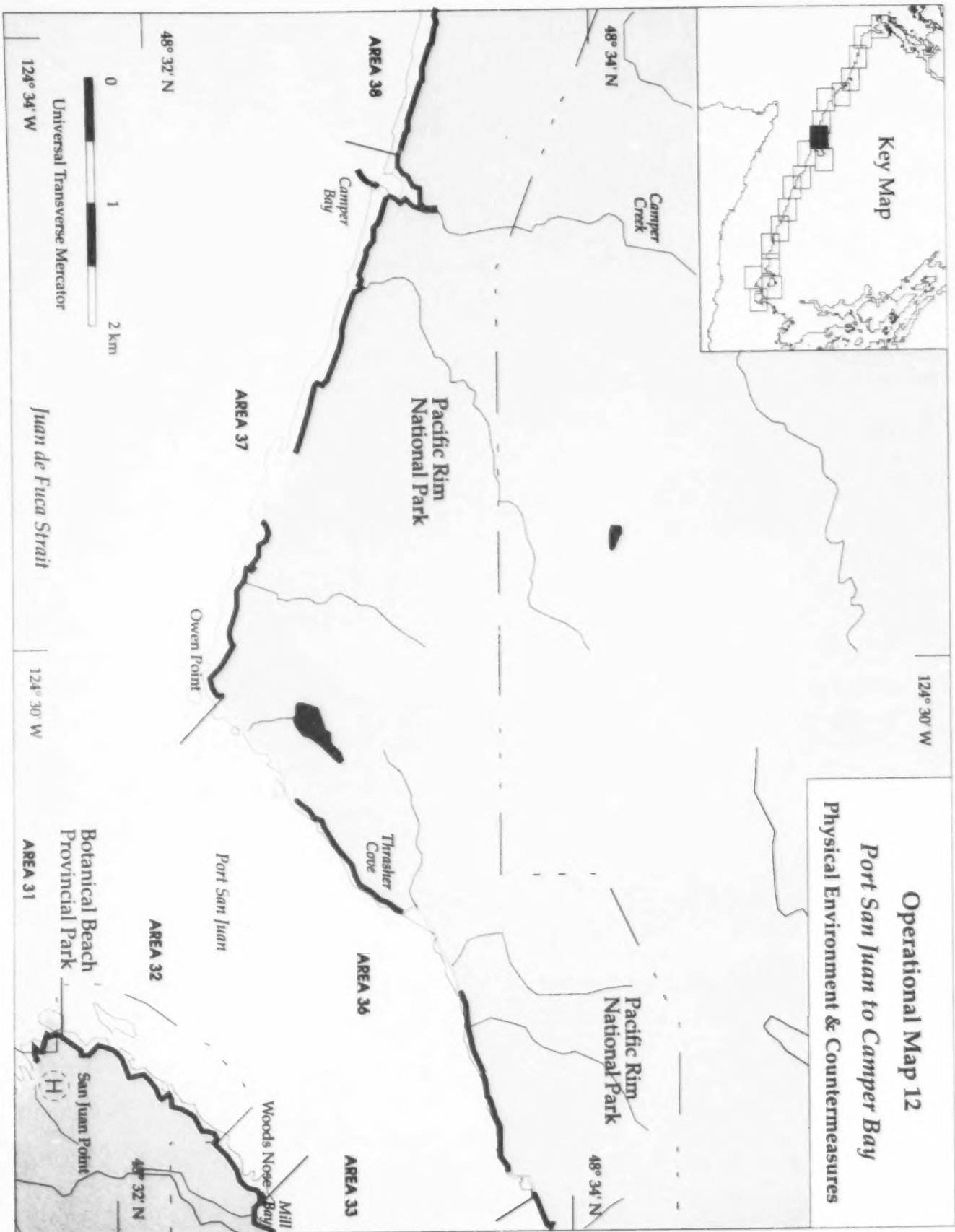




Operational Map 12

Port San Juan to Camper Bay

Physical Environment & Countermeasures



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 12 - Port San Juan to Camper Bay

ACCESS

The West Coast Trail lies remote from the shore in this area. There are no roads; direct shoreline access is limited to three unimproved trails leading from the West Coast Trail. Backshore cliffs generally line the entire section.

Extensive bedrock platforms, surge channels, nearshore rocks, reefs, waves, and surf prohibit marine access.

Landing at Camper Bay may be attempted with caution when wave and tidal conditions allow.

Helicopter landings on the intertidal bedrock at low tide would be possible in some locations.

An exception may be the small inlet at Camper Bay where relatively calm conditions will facilitate booming and skimming in the small embayment. Incoming slicks are unlikely to affect the creek, and protection booming is not recommended. The mouth of Camper Creek is a potential location for temporary storage of cleanup equipment and oily debris.

Legend

-  Cliff
-  Cliff with Platform
-  Cliff with Platform and Beach
-  Headland/Pocket Beach
-  Mixed Sediment Beach
-  Sand Beach
-  Intertidal Flats
-  Estuaries
-  Rocky Ledges/Reefs
-  Foreshore Flats
-  Staging Areas
-  Access (Marine or Land)
-  Anchorage
-  Temporary Anchorage
-  Helipad
-  Helicopter Landing Site

COUNTERMEASURES

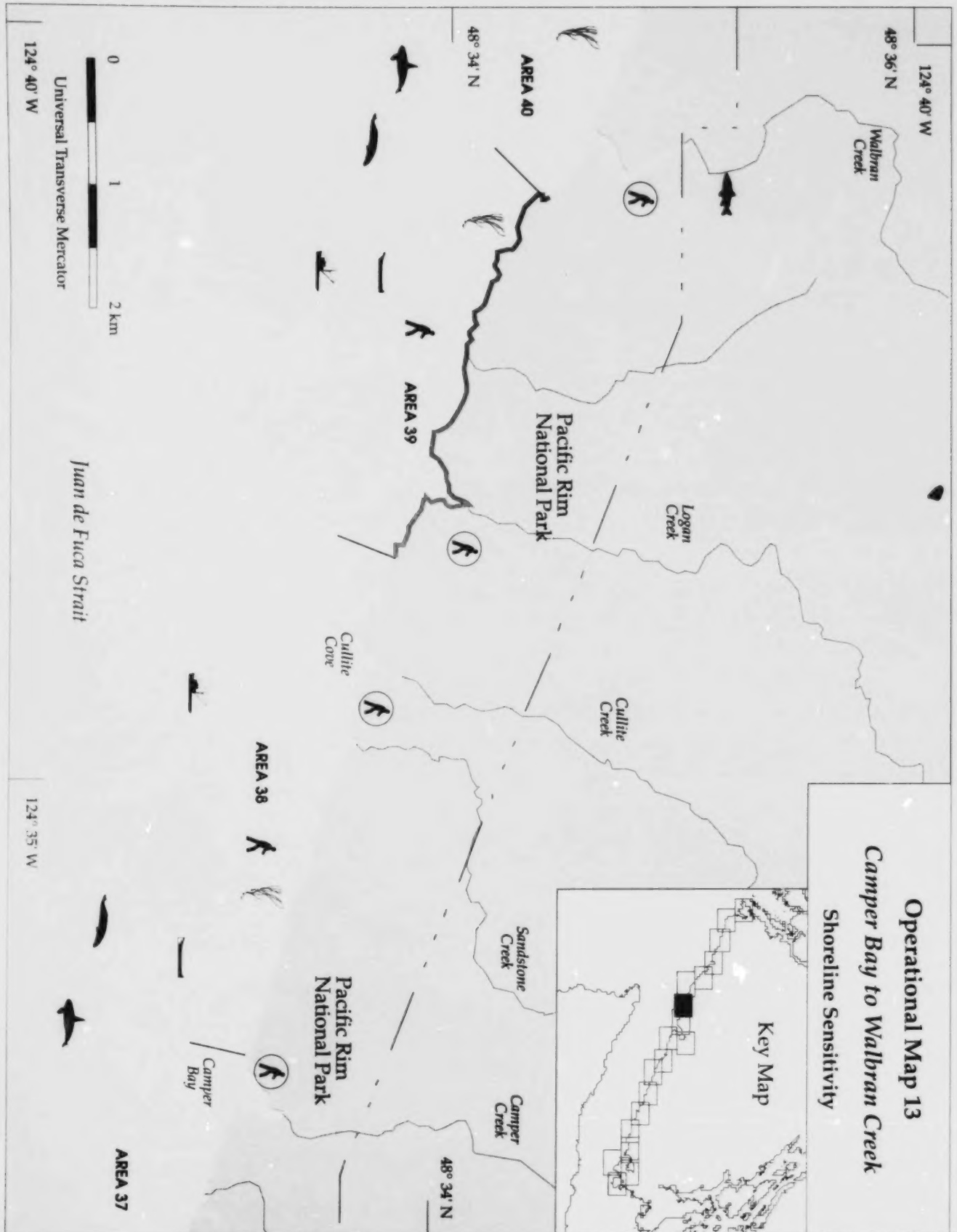
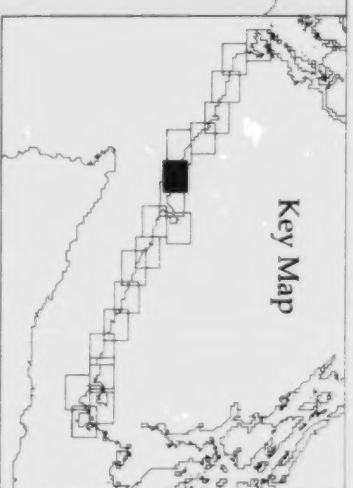
With an almost total lack of surface transport west of Owen Point, physical countermeasures operations would be limited to small crews working with continuous helicopter support for short periods. Expansive bedrock outcroppings backed by steep cliffs present a hazardous working environment. Return trips for personnel pickup may be hampered by weather or other problems, and escape routes may not always be apparent or exist. Intermittent high waves washing over tidal platforms might also occur. Localized accumulations of oil would be expected in numerous tidal pools and in and around boulders.

Surge channels, reefs, and rocks (particularly in the vicinity of small headlands) present a concern to any watercraft attempting landings; nearshore booming and skimming operations would not be possible along this section of coast.

Mechanical or manual intervention may not be practical in this area. The rock platforms backed by three-to-five metre cliffs will naturally self-clean over time, particularly during winter storms.

Operational Map 13 Camper Bay to Walbran Creek

Shoreline Sensitivity



Environmental Description

Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

*See Appendix A

No.	Name	Area	Sensitivity Ranking
37	Owen Point		22.5
38	Cullite Cove		23.3
39	Logan Creek		18.8
40	Walbran Creek		29.3

	Commercial Fisheries CF		Orca Or
	Recreation Local RL		Grey Whale GW
	Recreation Diffuse RD		Salmonid Spawning Sa
	Offshore Harvesting SH		Kelp Beds K

CF 38-39 A maximum of 750 commercial fishing boats per day fish for Chum salmon and a maximum of 100 commercial fishing boats per day fish for the other species of salmon from mid-September to mid-November in the area from Port San Juan to Cape Beale. An average of 1-2 crab boats per day set traps throughout the year in the area from Port San Juan to Cape Beale.

RL 37 A campsite for the West Coast Trail is located at Camper Bay. Large sailboats have used Camper Bay for moorage.

RL 38 A campsite for the West Coast Trail is located at Cullite Cove.

RL 39 A campsite for the West Coast Trail is located at Logan Creek.

RL 40 A campsite for the West Coast Trail is located at Walbran Creek.

RD 38-39 Mussels and Goose-neck barnacles are occasionally harvested from Otter Point to Bonilla Point. From May to November, an average of 5 boats per day fish for Lingcod in the area from Otter Point to Bonilla Point. An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds from San Juan Point to Bonilla Point. An average of 70 boats per day fish for all 5 species of salmon from June to September from Owen Point to Bonilla Point. Hikers use the West Coast Trail; Kayakers and divers use the marine area along the coast.

SH 38-39 Offshore native subsistence harvesting occurs in these areas.

Or 37-40 Transient pods of orcas may be found along the coast throughout the year.

GW 37-40 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

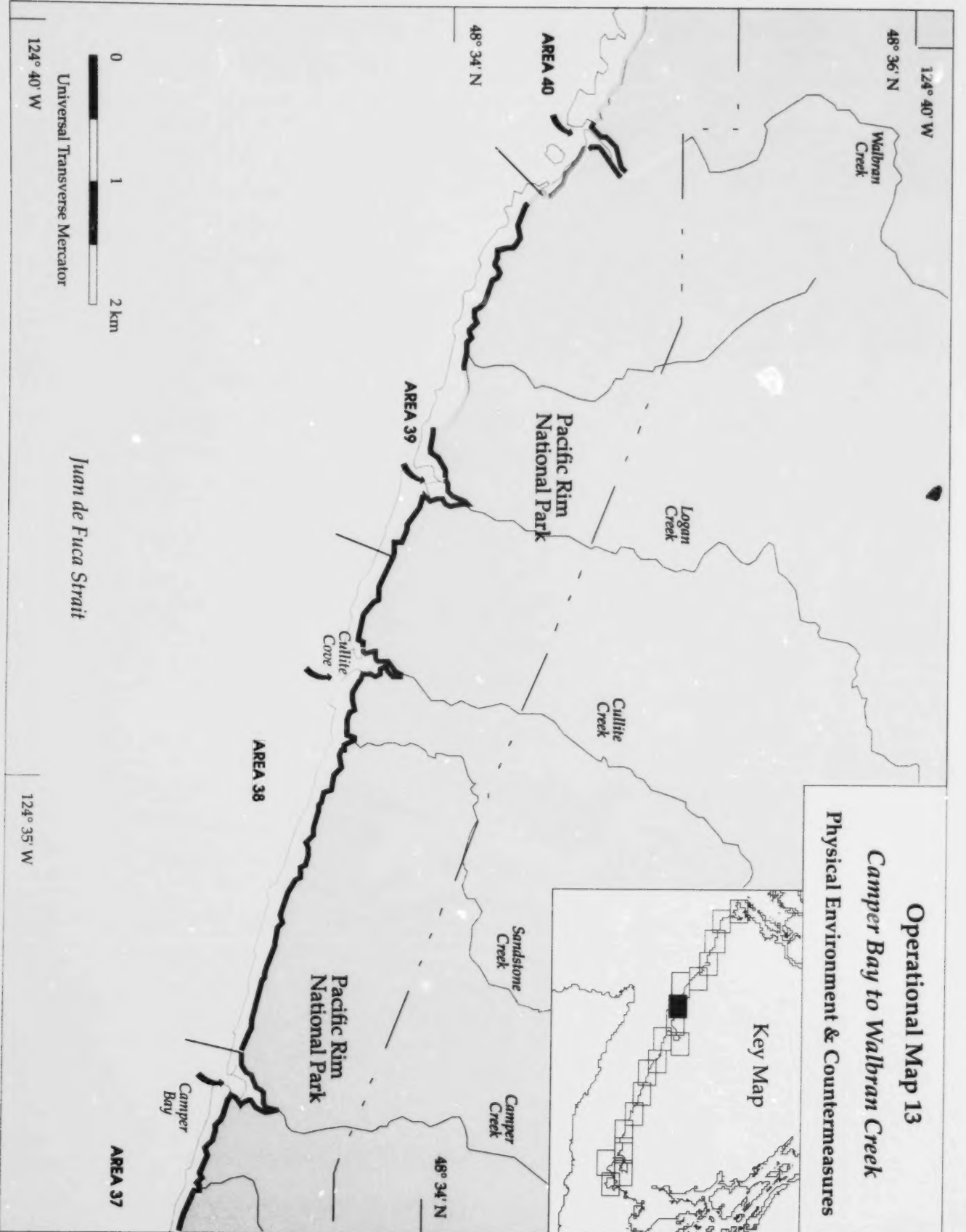
Sa 40 Walbran Creek is known to support populations of Coho (a few hundred), Chum (number unknown) and Steelhead (500-1,000) (D. Lindsay, pers.comm.). No escapement estimates have been made due to the inaccessibility of the creek.

K 38-40 Kelp beds occur sporadically along the shorelines in these areas.

SS 37-40 Pacific Rim National Park.



Operational Map 13 Camper Bay to Walbran Creek Physical Environment & Countermeasures



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 13 - Camper Bay to Walbran Creek

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

The West Coast Trail leading to Camper Bay, and Logan and Walbran Creeks provides the only means of reaching the shore on foot in this area.

Landings from the seaward side are severely restricted in this sector. Marine access may be possible at Camper Bay, Cullite Cove, and near the mouths of Logan and Walbran Creeks when wave conditions allow. The remainder of the shoreline is lined with wide bedrock platforms exposed to open ocean wave conditions.

Helicopter landings on the intertidal platform are possible during favourable tide and weather conditions.

COUNTERMEASURES

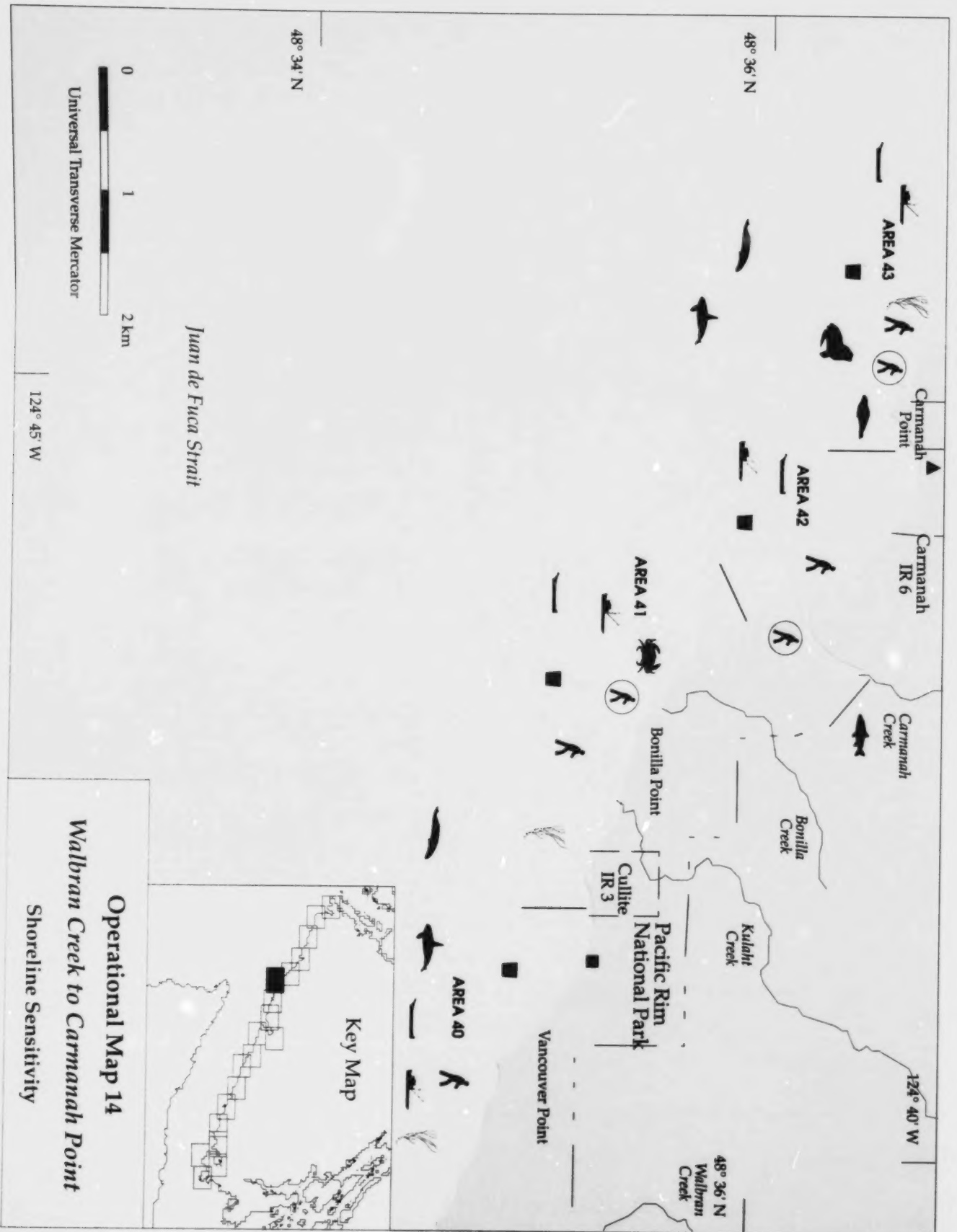
The placement of a skimmer and boom (approximately 30 m) at the small inlet at Camper Bay may allow oil recovery at low or high tide during relatively calm conditions. Incoming slicks are unlikely to influence the creek, and protection booming is not recommended. The mouth of Camper Creek is a potential location for temporary storage of cleanup equipment and oily debris.

A series of three pocket beaches to the west are located adjacent to significant surge zones. The deep channels reflect the high surf which pounds this sector of the coast. Nearshore booming and skimming operations would be impossible. While the first of these channels (Sandstone Creek), and third (Logan Creek) have limited or no sea access, the second (Cullite Creek) may be accessible during calm wave conditions. Mechanical removal of oil or flushing of oil into the surf zone could be attempted in this area.

At Walbran Creek, concentrating and skimming slicks could be attempted during calm conditions. The effectiveness of exclusion booming will be highly dependent on

wave conditions at the time of the spill. Manual oil removal methods at the shore may be necessary. Alternatively, flushing the mixed sediment beach with water and holding the removed oil in a containment boom could be tried.

The western area of Map 13 has higher cliffs with no beach; nearshore oil slicks would be expected to dissipate quickly in high energy waves.



Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Area	Sensitivity Ranking
40	Walbran Creek		22.3
41	Bonilla Point		37.2
42	Carmanah Creek		55.5
43	Carmanah Point		38.4

	Commercial Fisheries CF		Grey Whale GW
	Recreation Local RL		Salmonid Spawning Sa
	Recreation Diffuse RD		Shellfish Sh
	Offshore Harvesting SH		Kelp Beds K
	Harbour Seal HS		Heritage Site High H
	Sea Lion SL		Heritage Site Moderate H
	Orca Or		

CF 40-43 A maximum of 750 commercial fishing boats per day fish for Chum salmon and a maximum of 100 commercial fishing boats per day fish for the other species of salmon from mid-September to mid-November in the area from Port San Juan to Cape Beale. An average of 1-2 crab boats per day set traps throughout the year in the area from Port San Juan to Cape Beale.

CF 41 Gooseneck barnacles are harvested in the vicinity of Bonilla Point.

RL 41 From June to September, an average of 2 boats per day fish for halibut in the vicinity of Bonilla Point. A campsite for the West Coast Trail is located at Bonilla Point.

RL 42 A campsite for the West Coast Trail is located at Carmanah Creek.

RL 43 Fishermen fish for all species of salmon from June to September in the vicinity of Carmanah Point. Carmanah Point is a viewpoint for the sea lion haulout in the area.

RD 40-41 Mussels and Gooseneck barnacles are occasionally harvested from Otter Point to Bonilla Point. From May to November, an average of 5 boats per day fish for Lingcod in the area from Otter Point to Bonilla Point. An average of one-half the number of salmon fishermen fish for rockfish among the kelp beds from San Juan Point to Bonilla Point. An average of 70 boats per day fish for all 5 species of salmon from June to September from Owen Point to Bonilla Point.

RD 40-43 Hikers use the West Coast Trail; kayakers and divers use the marine area along the coast.

RD 42/43 Mussels and Gooseneck barnacles are occasionally harvested by hikers along the trail.

RD 43 Researchers and students from the Bamfield Research Station have occasional field trips to destinations along the coast from Carmanah Point north to Bartley Sound.

SH 40-43 Both offshore and intertidal native subsistence harvesting occur in these areas.

HS 43 Harbour seals (133 animals) haul out at Carmanah Point.

SL 43 Steller sea lions also use Carmanah Point as a haulout year round, with numbers peaking in the summer at 200.

Or 40-43 Transient pods of orcas may be found along the coast throughout the year.

GW 40-42 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

GW 43 Grey whales are frequently sighted off Carmanah Point. They may be found at any time between February and December.

SA 42 Chinook and Coho salmon, Steelhead and sea-run Cut-throat trout have been observed in the lower reaches of Carmanah Creek, below an impassable falls at 2.7 km from the sea. There are no escapement records for this creek, and populations are likely small due to the limited suitable spawning and rearing habitats available to these species (McInnis and Pollard, 1977).

SH 41 Gooseneck barnacles occur in abundance at Bonilla Point.

K 40/41/43 Moderate densities of kelp occur in these areas.

H 40 Sensitive. This unit contains Heritage Site #110.

H 42 Sensitive. This unit contains Heritage Site #111.

SS 40-41 The Cullite Indian Reserve is located on the border of these areas.

SS 42 The Carmanah Indian Reserve is located in this area.

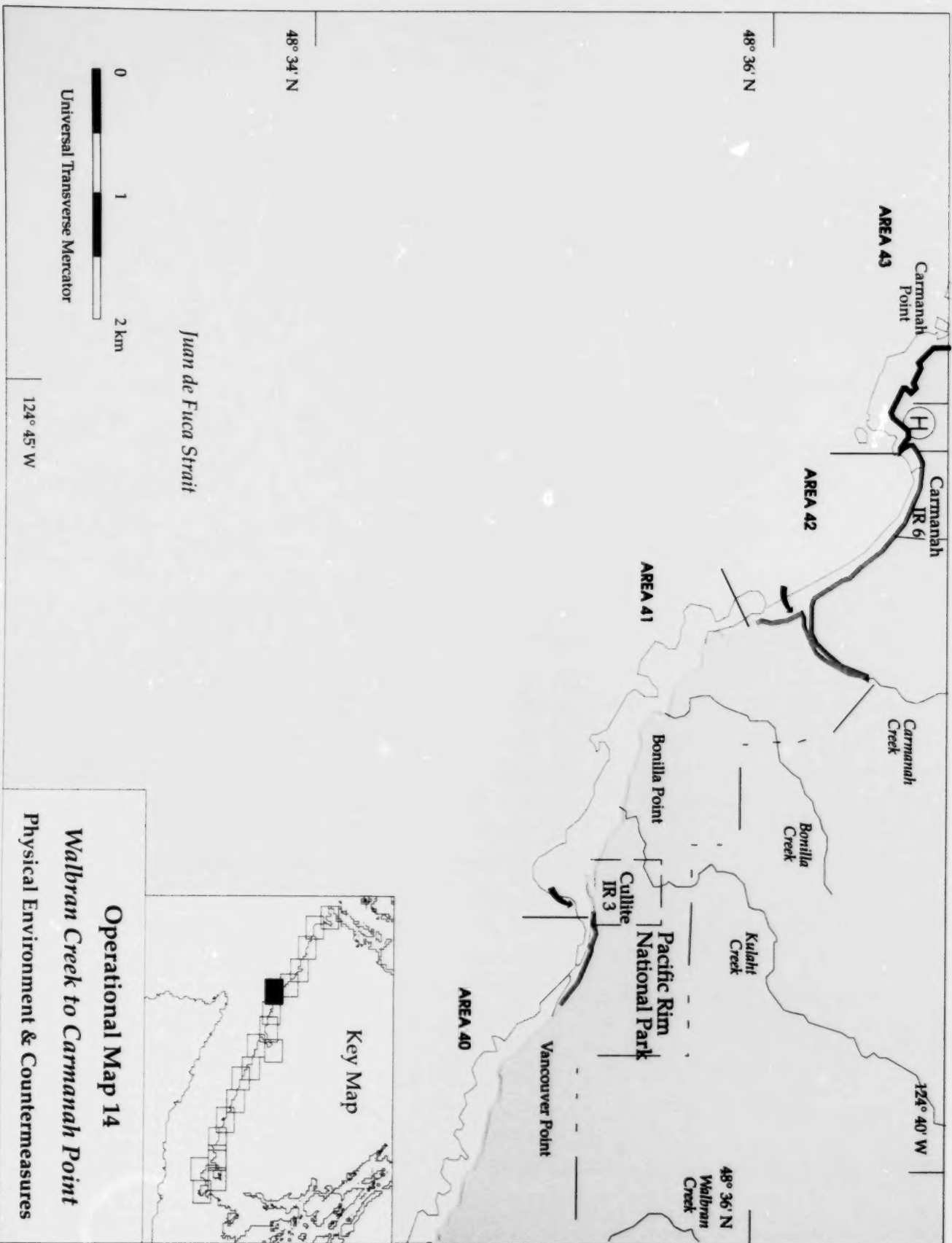
SS 40-43 Pacific Rim National Park.

Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

For detailed information about heritage sites, contact the B.C. Ministry of Environment, Environmental Emergency and Coastal Protection Branch or the B.C. Ministry of Municipal Affairs, Recreation and Culture, Heritage Conservation Branch (in Victoria).





PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 14 - Walbran Creek to Carmanah Point

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

Apart from the West Coast Trail, the trail down the Carmanah Creek valley (connecting with upper valley logging roads) provides the only other means of reaching the coast by land. The trail follows the bedrock platform from Vancouver Point to the headlands of Carmanah Point.

A sand beach located to the east of the Cullite Indian Reserve could also be cleaned using mechanical equipment (navigation through the narrow entrance is difficult).

Marine access is prohibited by extensive bedrock platforms and submerged rocks along the entire section. When wave conditions permit, shallow-draft vessel landing is possible at the beach at the mouth of Carmanah Creek, and at the Cullite Indian Reserve (the entrance at the latter is restricted). Sea conditions dictate the possibility of landing at both locations.

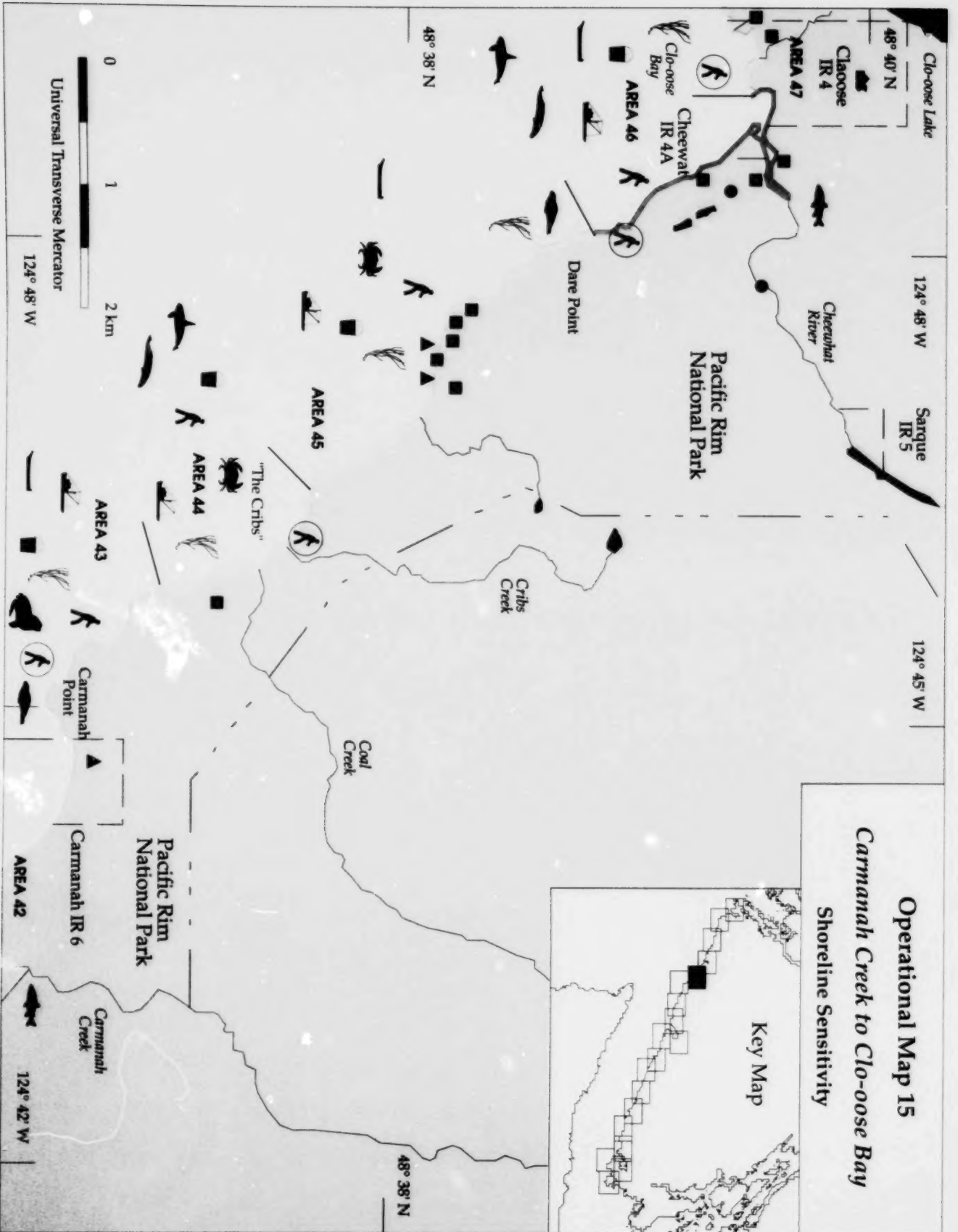
Rock platforms along the shore, the Cullite Reserve, Carmanah Beach, and the lighthouse at Carmanah Point provide potential sites for helicopter operations.

COUNTERMEASURES

The veneer of coarse sediments backed by log debris is relatively continuous over much of this section and could become oiled during a spill (depending on tides and sea conditions). Cleaning of areas with high recreational value (e.g., the camping sites at Carmanah and Bonilla Creeks) would have priority. Response options include burning of oiled logs and manual removal of oily debris.

The use of booms and skimmers in the vicinity of Carmanah Creek is doubtful in view of the surf that develops there. The expansive sand beach may be suited to mechanical cleanup supplemented by manual methods. Heavy equipment could be brought into the beach during favourable sea conditions to assist the cleanup. The flat terrain at the creek mouth could be used for both the storage of collected materials and the staging of equipment.

Operational Map 15 Carmannah Creek to Clo-oose Bay Shoreline Sensitivity



Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Sensitivity Ranking
42	Carmanah Creek	30.5
43	Carmanah Point	22.9
44	Coal Creek	27.1
45	E of Dare Point	27.1
46	Cheewat River estuary	43.4
47	Stanley Beach	34.5

	Commercial Fisheries CF		Grey Whale GW
	Recreation Local RL		Salmonid Spawning Sa
	Recreation Diffuse RD		Shellfish Sh
	Intertidal Harvesting SH		Kelp Beds K
	Offshore Harvesting SH		Heritage Site High H
	Harbour Seal HS		Heritage Site Moderate H
	Sea Lion SL		Heritage Site Low H
	Orca Or		

CF 43-47 A maximum of 750 commercial fishing boats per day fish for chum salmon and a maximum of 100 commercial fishing boats per day fish for the other species of salmon from mid-September to mid-November in the area from Port San Juan to Cape Beale. An average of 1-2 crab boats per day set traps throughout the year in the area from Port San Juan to Cape Beale.

CF 44 Razor clams are occasionally harvested from an area west of Carmanah Point.

CF 45 Abalone and Gooseneck barnacles are occasionally harvested along the shorelines in this area.

RL 43 Fishermen fish for all species of salmon from June to September around the Carmanah Point. The Carmanah Point is a viewpoint for the sea lion haulout in the area.

RL 44 A campsite for the West Coast Trail is located at Coal Creek.

RL 46 A campsite for the West Coast Trail is located west of Dare Point.

RL 46/47 There is good anchorage for sailboats in Clo-oose Bay.

RL 47 A campsite for the West Coast Trail is located at Clo-oose Bay.

RD 43-46 Hikers use the West Coast Trail; kayakers and divers use the marine area along the coast. Mussels and Gooseneck barnacles are occasionally harvested by hikers along the trail. Researchers and students from the Bamfield Research Station have occasional field trips to destinations along the coast from Carmanah Point north to Barkley Sound.

RD 46 Crab traps are occasionally set in the areas between the Cheewat River and the Nitinat River. Canoeists occasionally paddle from Nitinat Lake to points on the West Coast Trail such as Cheewat River.

SH 43-47 Both offshore and intertidal native subsistence harvesting occur in these areas.

HS 43 Harbour seals (133 animals) haul out at Carmanah Point.

HS 45 Harbour seals (35 animals) haul out at Dare Point.

SL 43 Steller Sea lions also use Carmanah Point as a haulout year round, with numbers peaking in the summer at 200.

Or 43-47 Transient pods of orcas may be found along the coast year-round.

GW 44-47 Grey whales are frequently sighted off Carmanah Point. They may be found at any time between February and December.

GW 43 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

Sa 42 Chinook and Coho salmon, Steelhead and sea-run Cut-throat trout have been observed in the lower reaches of Carmanah Creek, below an impassable falls at 2.7 km from the sea. There are no escapement records for this creek, and populations are likely small due to the limited suitable spawning and rearing habitats available to these species (Melnlis and Pollard, 1977).

Sa 46 The Cheewat River supports 3 salmon runs. The maximum recorded escapements are Coho 1,500; Chum 400; and Sockeye 5,000.

Sh 44 Razor clams are found on the beach north of Carmanah Point.

Sh 45 Gooseneck barnacles and abalone are reported to occur east of Dare Point.

K 43-45/47 Kelp beds occur sporadically along the shorelines in these areas.

H 42 Sensitive. This unit contains Heritage Site # 111.

H 44 Sensitive. This unit contains Heritage Site # 112.

H 45 Extremely sensitive. This unit contains Heritage Sites # 113 - 119.

H 46 Highly sensitive. This unit contains Heritage Sites # 120 - 124.

H 47 Extremely sensitive. This unit contains Heritage Sites # 125 - 126.

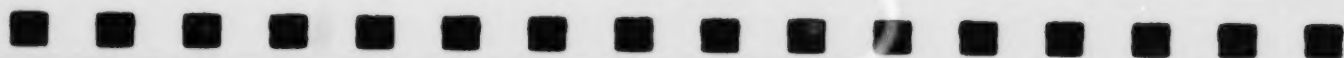
SS 42 The Carmanah Indian Reserve is located in this area.

SS 46/47 The Cheewat and Clooose Indian Reserves are located in this area.

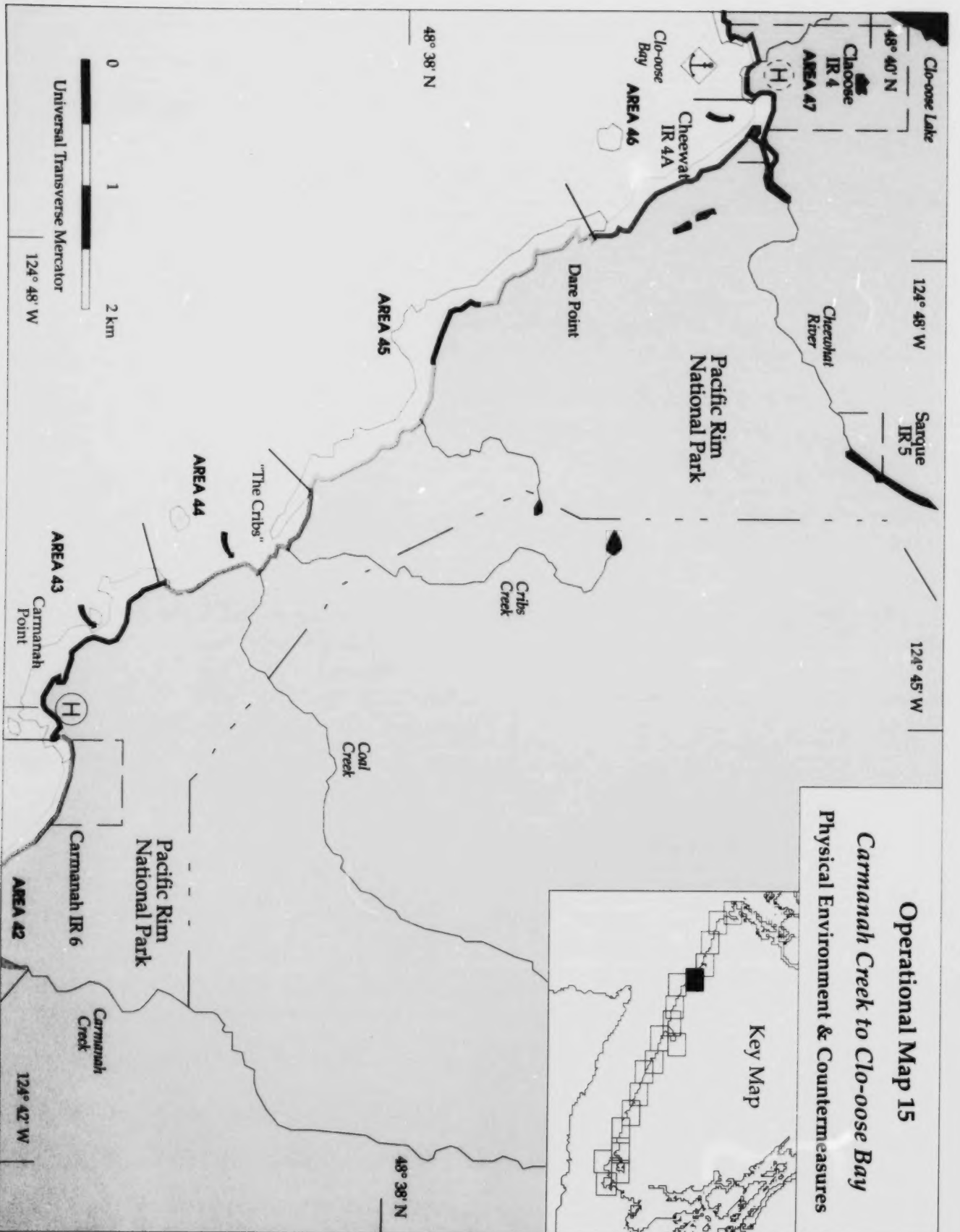
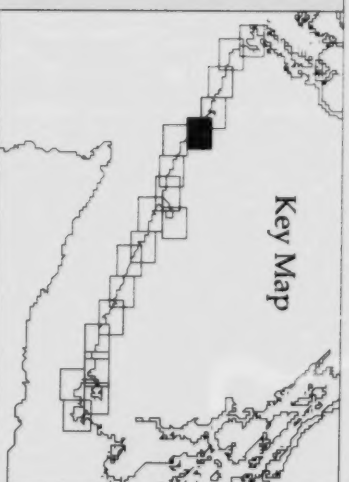
SS 43-47 Pacific Rim National Park.

Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).



Operational Map 15 Carmannah Creek to Clo-oose Bay Physical Environment & Countermasures



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 15 - Carmannah Creek to Clo-oose Bay

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

Crews could reach the shore in this area via seven unimproved trails which lead from the West Coast Trail.

Marine access is limited to possible shallow-draft boat landings at the beaches to the west of Carmannah Creek, to the east of "The Cribbs", at the mouth of the Cheewhat River, and at Clo-oose. Extensive bedrock platforms along the exposed coast prohibit vessel landings at other locations.

Helicopter operations are possible at the lighthouse at Carmannah Point and at the mouth of the Cheewhat River.

COUNTERMEASURES

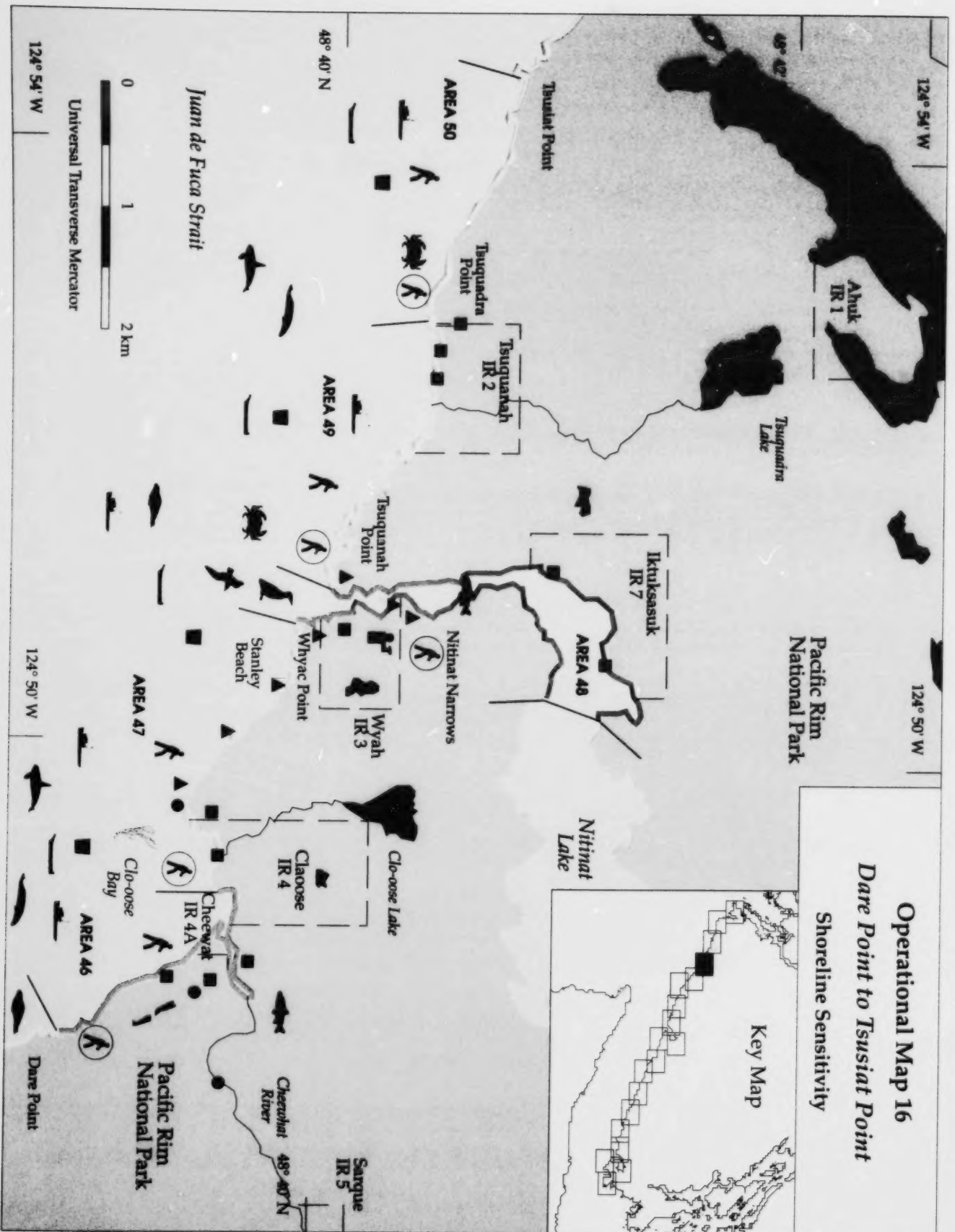
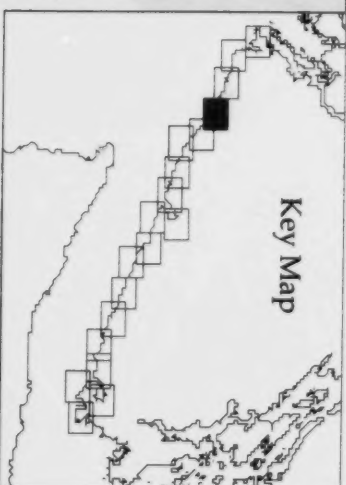
Oil transported to this part of the coast will have a low persistence; the rocky outcroppings of Carmannah Point, the low cliffs to the west of Dare Point, and the headlands at Clo-oose, are all high energy zones.

The sand beach at "The Cribbs" could be cleaned of stranded oil using mechanical equipment. Sites for landing from the water side would have to be carefully selected due to the presence of bedrock outcroppings in front of the beach. The sand cover to the east of "The Cribbs" is far less accessible, and would be difficult to clean.

An extensive sand beach located in the vicinity of the Cheewhat River could be cleaned with heavy equipment brought by shallow-draft landing craft (sea conditions permitting). The flat beach near the mouth of the river could serve as a staging area for cleanup activities in this general area. Booming and concentrating oil nearshore in this area would be a questionable operation due to the configuration of the river mouth and its wave exposure.

The smaller beach to the west at Clo-oose requires independent marine access and would be more suited to manual restoration methods.

Operational Map 16 Dare Point to Tsusiat Point Shoreline Sensitivity



SHORELINE SENSITIVITY

Operational Map 16 - Dare Point to Tsusiat Point

Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Area	Sensitivity Ranking
46	Cheewhat River estuary		43.4
47	Stanley Beach		34.5
48	Nitinat Narrows		44.9
49	Tsuanah Point		31.0
50	E of Tsusiat Point		33.1

	Commercial Fisheries CF		Orca Or
	Tourism T		Grey Whale GW
	Recreation Local RL		Salmonid Spawning Sa
	Recreation Diffuse RD		Shellfish Sh
	Offshore Harvesting SH		Kelp Beds K
	Many Birds B		Heritage Site High H
	Bird Colony BC		Heritage Site Moderate H
	Harbour Seal HS		Heritage Site Low L

CF 46-50 A maximum of 750 commercial fishing boats per day fish for chum salmon and a maximum of 100 commercial fishing boats per day fish for the other species of salmon from mid-September to mid-November in the area from Port San Juan to Cape Beale. An average of 1-2 crab boats per day set traps throughout the year in the area from Port San Juan to Cape Beale.

CF 46-50 One of the more popular spots is offshore of the mouth of the Nitinat River. The Nitinat River area will see an increase in Chinook salmon fishing in the 1992-1993 season due to an increase in the Chinook escapement from the Nitinat Hatchery.

T 48 The Dittidat Indian Band operates a ferry service at Nitinat Narrows in the summer for hikers on the West Coast Trail.

RL 46 A campsite for the West Coast Trail is located west of Dare Point.

RL 46/47 There is good anchorage for sailboats in Clo-oose Bay.

RL 47 A campsite for the West Coast Trail is located at Clo-oose Bay.

RL 47/48 A maximum of 50 boats per day fish for all species of salmon from June to September around the mouth of the Nitinat River. Approximately 2 boats per day fish for Lingcod and rockfish in the summer months in the vicinity of Nitinat River.

RL 48 Fishermen fish for Chinook, Sockeye, and Coho salmon off the Nitinat sand bar at the mouth of the Nitinat River. A campsite for the West Coast Trail is located at Nitinat Narrows.

RL 49 A campsite for the West Coast Trail is located at Tsuanah Point.

RL 50 A campsite for the West Coast Trail is located at Tsuanah Point.

RD 46-50 Hikers use the West Coast Trail; kayakers and divers use the marine area along the coast. Mussels and Goose-neck barnacles are occasionally harvested by hikers along the trail. Researchers and students from the Bamfield Research Station have occasional field trips to destinations along the coast from Carmanah Point north to Barkley Sound. Canoeists occasionally paddle from Nitinat Lake to points on the West Coast Trail such as Cheewhat River. RD 46-48 Crab traps are occasionally set in the areas

between the Cheewhat River and the Nitinat River.

RD 49,50 A maximum of 50 boats per day fish for all species of salmon from June to September around the mouth of the Nitinat River. Approximately 2 boats per day fish for Lingcod and rockfish in the summer months in the vicinity of Nitinat River. The area between Tsuanah Point and Tsuanah Point has good anchorage for sailboats.

SH 46-50 Both offshore and intertidal native subsistence harvesting occur in these areas.

B 48 Diving ducks concentrate in and off Nitinat Narrows in winter. Dabbling ducks, including swans, regularly occur in the Narrows and in Nitinat Lake in the winter.

BC 48 A colony of Pelagic cormorants (50 pairs) occurs off Whycat Point at the mouth of Nitinat Narrows.

HS 45 Harbour seals (11 animals) haul out at Dare Point.

HS 49 Harbour seals (12 animals) haul out at Tsuanah Point.

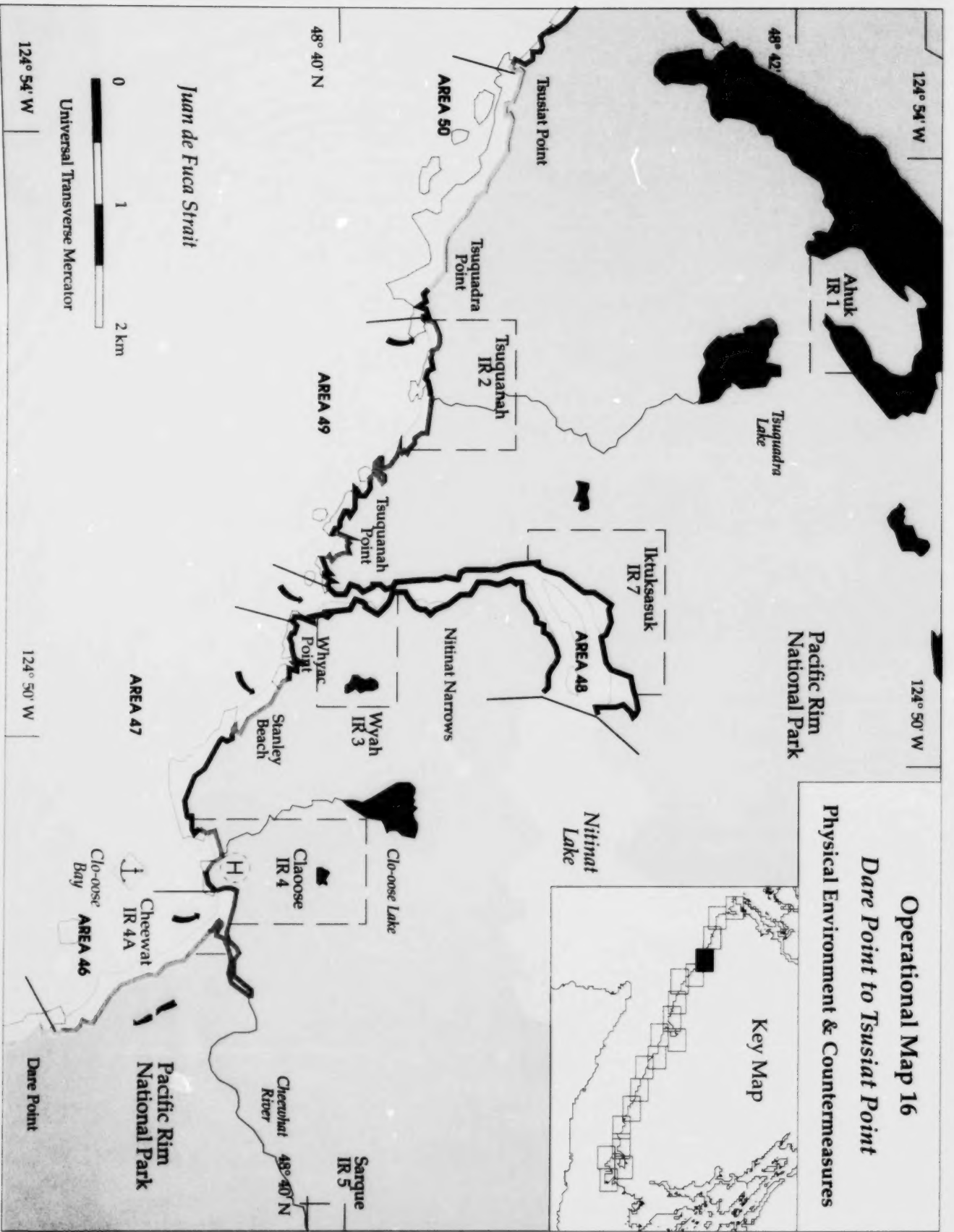
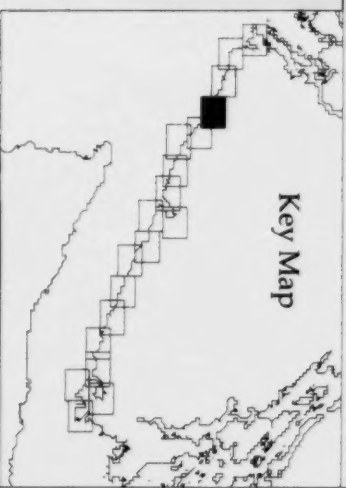
Or 46-50 Transient pods of orcas may be found along the coast throughout the year.

GW 46-50 Grey Whales are most frequently sighted during their spring and fall migrations, but may be found at any time between February and December.

Sa 46 The Cheewhat River supports 3 salmon runs. The maximum recorded escapements are Chum 400; Coho 1,500; and Sockeye 5,000.

Sa 48 The Nitinat system represents the most productive salmon area in the study region. Approximately 10 million Chinook and 5 million Chum fry are released into the Nitinat River each year. All 6 salmonid species spawn in rivers that empty into Nitinat Lake.

Operational Map 16 Dare Point to Tsusiat Point Physical Environment & Countermeasures



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 16 - *Dare Point to Tsusiat Point*

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

Seven unimproved trails leading off the West Coast Trail provide the only means of reaching the shore on foot.

Marine access may be possible at several locations if wave conditions allow: at beaches to the southeast of the Cheewhat River mouth, at Stanley Beach, through the Nitinat Narrows (only under specific tidal conditions and with local consultation - fast currents reaching 8 knots, and a shallow sand bar restrict passage at Nitinat Narrows), and at the beach east of Tsuquadra Point. Boat landings along the remainder of the shoreline are prohibited by wide bedrock platforms and rough seas.

Floatplane landings are possible on Nitinat Lake.

COUNTERMEASURES

Much of this coastal section is characterized by an extensive rocky platform covered with coarse sediments, and backed by log debris. There would be serious transportation problems in operating along this coast. Bioremediation may be the most appropriate restoration technique for beaches with a thick, coarse sediment layer.

Many sandy beaches, which are located in the vicinity of the Cheewhat River, could be cleaned of oil accumulations with heavy equipment (moved by shallow-draft landing craft, sea conditions permitting). The flat beach near the mouth of the river could serve as a staging area for cleanup activities in this general area. Booming and concentrating oil nearshore would be a questionable operation due to the configuration of the river mouth and rough seas.

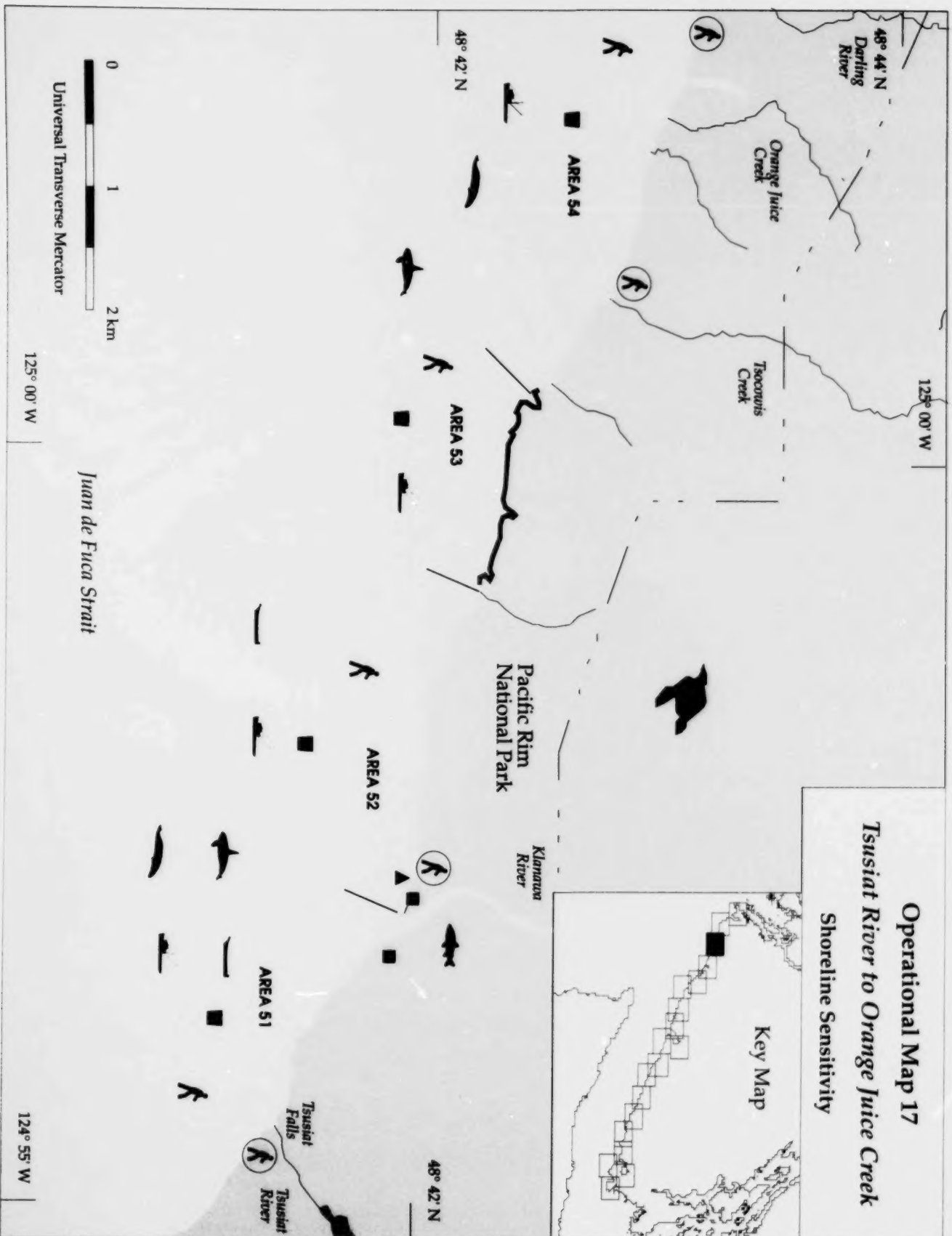
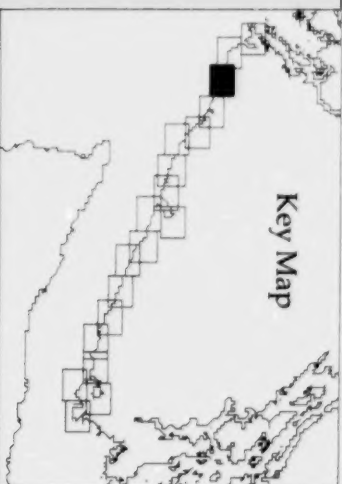
The pocket beach to the west at Clo-oose would require marine access; manual cleanup methods would be appropriate for this area. Rocky headlands west of Clo-oose would have a low capacity to retain stranded oil in the high waves common to this area.

Stanley Beach is comprised of sandy sediments which could be cleaned using manual methods during conditions which permit crews to land by boat.

The high currents between Whyac Point and Tsuquanah Point would prevent deployment of diversion booms at the entrance to Nitinat Narrows. Oil deposited on the beach at the eastern side of the Narrows would require manual removal. There is a possibility that oil may advance as far as the inner sections of the Narrows.

The pocket beach at Tsuquanah Point is limited in size and dangerous for boat landing. Manual cleanup methods could be considered only during calm, slack tide conditions.

Operational Map 17 Tsusiat River to Orange Juice Creek Shoreline Sensitivity



Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Area	Sensitivity Ranking
51	W of Tsusiat Point		32.2
52	W of Klamawa River		25.3
53	W of Klamawa River		18.6
54	E of Pachema Point		23.4

	Commercial Fisheries CF		Grey Whale GW
	Recreation Local RL		Salmonid Spawning Sa
	Recreation Diffuse RD		Heritage Site High H
	Intermittent Harvesting SH		Heritage Site Moderate H
	Offshore Harvesting SH		Heritage Site Low H
	Orca Or		

CF 51-54 A maximum of 750 commercial fishing boats per day fish for chum salmon and a maximum of 100 commercial fishing boats per day fish for the other species of salmon from mid-September to mid-November in the area from Port San Juan to Cape Beale. An average of 1-2 crab boats per day set traps throughout the year in the area from Port San Juan to Cape Beale.

RL 51 A campsite for the West Coast Trail is located at Tsusiat Falls.

RL 52 A campsite for the West Coast Trail is located at the Klamawa River.

RL 54 Campsites for the West Coast Trail are located at Darling River and Tsoconowis Creek.

RD 51-54 Hikers use the West Coast Trail; kayakers and divers use the marine area along the coast. Mussels and Gooseneck barnacles are occasionally harvested by hikers along the trail. Researchers and students from the Bamfield Research Station have occasional field trips to destinations along the coast from Carmanah Point north to Barkley Sound.

SH 51-54 Intertidal native subsistence harvesting occurs in these areas.

SH 51-52 Offshore native subsistence harvesting occurs in these areas.

Or 51-54 Transient pods of orcas may be found along the coast throughout the year.

GW 51-54 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

Sa 51 The Klamawa River supports small runs of the following salmonid species: Chum 3,500; Chinook 75; Coho 750; and Steelhead 200.

Swiftsure Bank is located offshore this area. It is a very important salmon and groundfish fishing area. In addition, some 200 sea-run Cut-throat trout spawn in the Klamawa, and inhabit the shallow nearshore area 1-2 km on either side of the river's mouth.

H 51 Highly sensitive. This unit contains Heritage Sites #143 - 144.

H 52 Sensitive. This unit contains Heritage Site #145.

SS 51-54 Pacific Rim National Park.

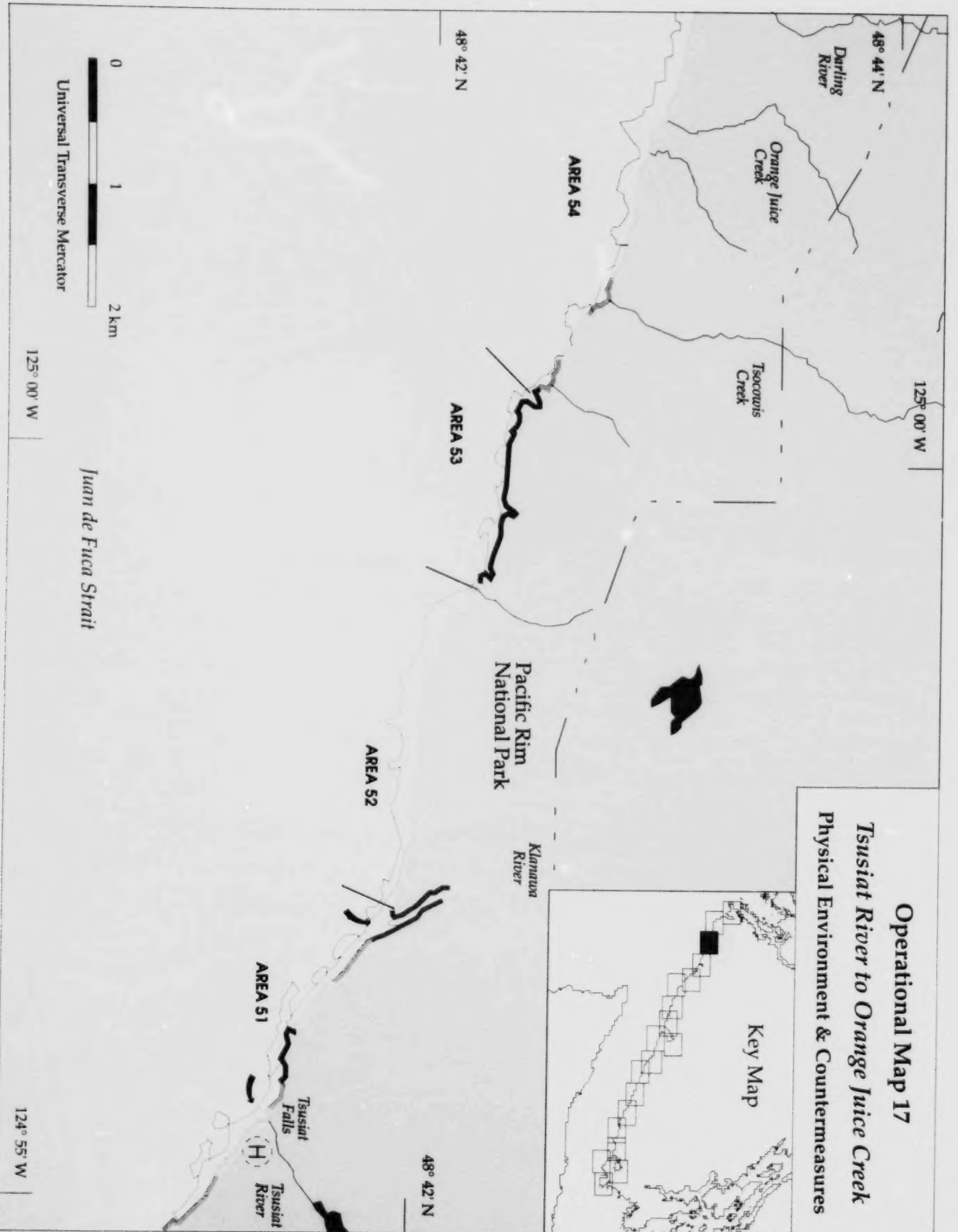
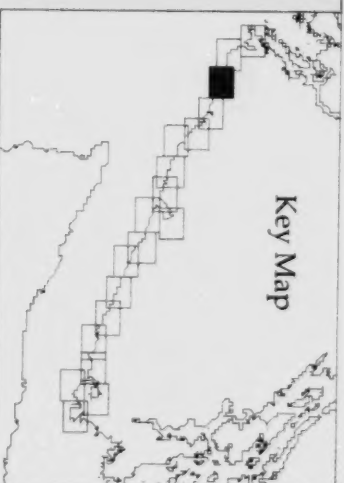
Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).

For detailed information about heritage sites, contact the B.C. Ministry of Environment, Environmental Emergency and Coastal Protection Branch or the B.C. Ministry of Municipal Affairs, Recreation and Culture, Heritage Conservation Branch (in Victoria).



Operational Map 17 Tsusiat River to Orange Juice Creek Physical Environment & Countermeasures



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 17 - *Tsusiat River to Orange Juice Creek*

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland / Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges / Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

Six side trails from the West Coast Trail provide the only land-based means of reaching the shore in this area.

Marine access is generally prohibited throughout this section by bedrock platforms and adverse wave conditions. Shallow-draft vessel landings may be possible along the beach at the mouth of the Tsusiat River, and at the mouth of the Klanawa River.

Tsusiat River would provide a suitable area for helicopter operations at low tide.

COUNTERMEASURES

Tsusiat River and Falls are widely used by hikers. These areas would require a high level of cleanup if oil stranding occurs. Manual labour would be necessary to remove oily debris.

The western section consists of rocky, rugged shore with little, if any, backshore area followed by a section of mixed-sediment beaches. Sea landings would be difficult along this sector of shoreline.

The beach widens to the west, finally forming a more definitive foreshore area at the Klanawa River where shallow-draft vessel landings may be possible. Booming (50-100 m boom) and collection of oil slicks could be tried at this recreational area during times when the river mouth is accessible. Portable skimmers may be effective in a pocket of water which forms at both low and high tide.

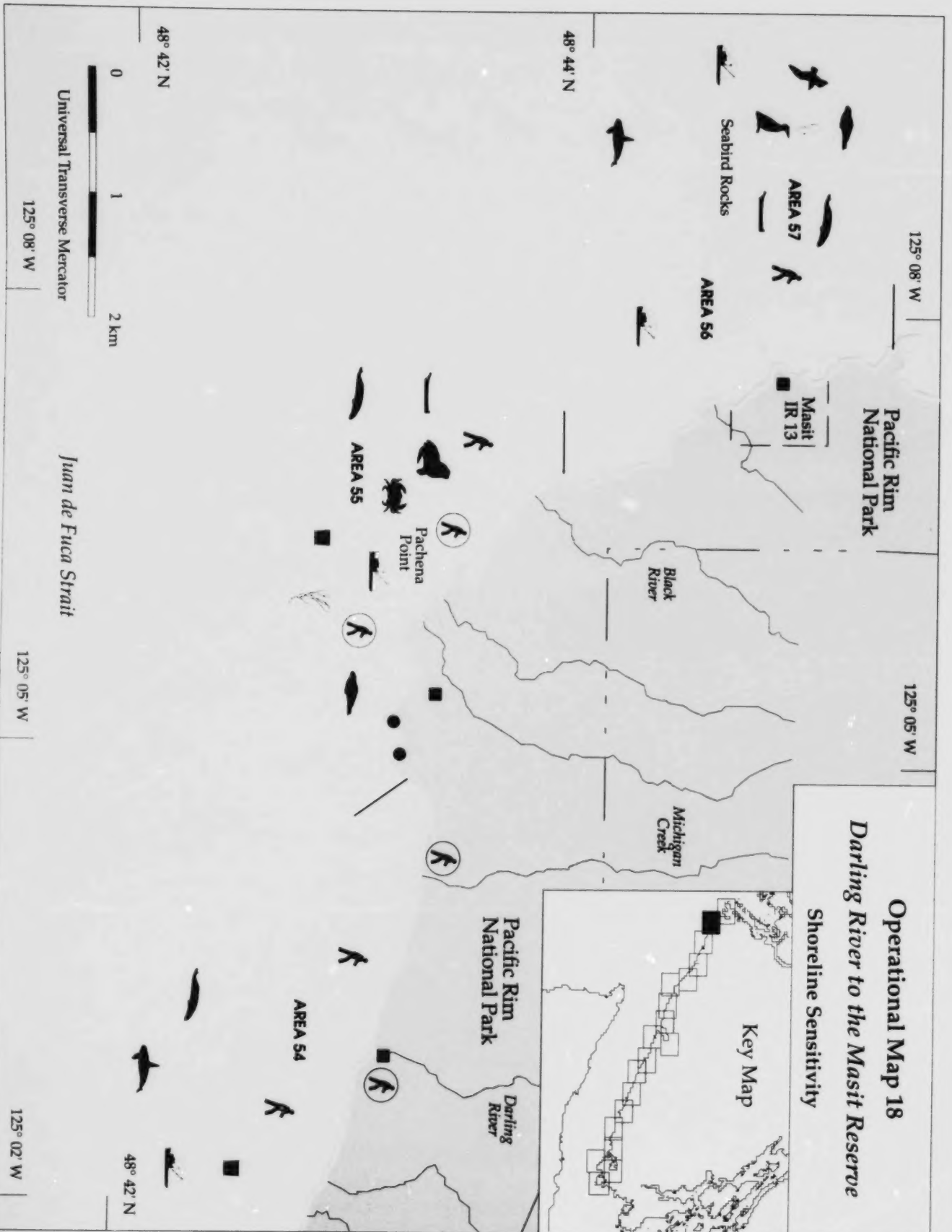
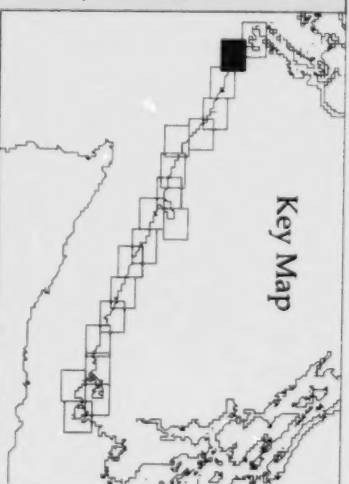
Beyond the Klanawa River, the bedrock platform broadens considerably; the platform in this area is characterized by occasional boulders on the surface and a narrow backshore wedge comprised of mixed sediments. The difficulty in transporting equipment severely restricts the cleanup options for this stretch of coast. Cleaning would be imprac-

tical in areas where there is no veneer and/or backshore cliffs. Bioremediation techniques could be tried in the narrow band of sediment.

A series of three pocket beaches between the mouths of the Klanawa River and Orange Juice Creek have finer, sandy sediments. The most westerly beach is partially protected by rocky outcroppings and has a wider foreshore zone. Although boat landings may be impossible, manual cleanup methods could be applied (with subsequent helicopter transport of debris). Small dunes above the narrow beach west of Orange Juice Creek are vulnerable to disturbance.

Booming is not recommended at Tsowcowis Creek since no distinct water pocket develops at its mouth. There is no physical reason to expect oil to accumulate preferentially in this area. The bedrock platform would hamper logistics and cleanup.

Operational Map 18 Darling River to the Masit Reserve Shoreline Sensitivity



SHORELINE SENSITIVITY

Operational Map 18 - Darling River to Masit Reserve

Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Area	Sensitivity Ranking
54	E of Pachena Point		23.4
55	Pachena Point		28.2
56	Masit Reserve		23.6
57	Seabird Rocks		21.0

	Commercial Fisheries CF		Sea Lion SL
	Recreation Local RL		Orca Or
	Recreation Diffuse RD		Grey Whale GW
	Intertidal Harvesting SH		Shellfish Sh
	Offshore Harvesting SH		Kelp Beds K
	Bird Colony BC		Heritage Site Moderate H
	Harbour Seal HS		Heritage Site Low H

CF 54-57 A maximum of 750 commercial fishing boats per day fish for Chum salmon and a maximum of 100 commercial fishing boats per day fish for the other species of salmon from mid-September to mid-November in the area from Port San Juan to Cape Beale. An average of 1-2 crab boats per day set traps throughout the year in the area from Port San Juan to Cape Beale.

CF 55 Goose-neck barnacles are harvested in the vicinity of Pachena Point.

RL 54 Campsites for the West Coast Trail are located at Michigan Creek and Darling River.

RL 55 Fishermen fish for all 5 species of salmon around the Pachena Point area. To the west of Pachena Point is the "Flat Rocks" viewpoint where one can watch the sea lion haulout.

RD 54-56 Hikers use the West Coast Trail; kayakers and divers use the marine area along the coast. Mussels and Gooseneck barnacles are occasionally harvested by hikers along the trail. Researchers and students from the Bamfield Research Station have occasional field trips to destinations along the coast from Carmanah Point north to Barkley Sound.

RD 57 Drivers use this area along the West Coast Trail. Researchers and students from the Bamfield Research Station have occasional field trips to destinations along the coast from Carmanah Point north to Barkley Sound.

SH 54,55 Intertidal native subsistence harvesting occurs in these areas.

SH 55-57 Offshore native subsistence harvesting occurs in these areas.

BC 57 A large, multi-species colony occurs at Seabird Rocks, a rocky islet that supports a lush growth of grasses and sedges surrounding a central band of salmonberry.

Species **No. Birds** **% of West Vancouver Is. Breeding Population**

Fork-tailed Storm Petrel	380	0.4%
Least Storm Petrel	860	0.3%
Pelagic Cormorant	32	1.4%
Black Oystercatcher	10	1.7%
Glaucous-winged Gull	362	2.5%
Pigeon Guillemot	65	9.6%
Cassin's Auklet	320	0.4%
Rhinoceros Auklet	260	11.5%
Tufted Puffin	16	0.2%

HS 55 A Harbour seal haulout (23 animals) occurs on the east side of Pachena Point.

HS 57 Harbour seals haul out at Seabird Rocks (133 animals).

SL 55 A sea lion haulout is found on the west side of Pachena Point. 100-130 Steller sea lions occupy the site in fall, winter and spring; a few remain on the site through the summer.

Or 54-57 Transient pods of orcas may be found along the coast throughout the year.

GW 54 Grey whales are most frequently sighted along the coast during their spring and fall migrations, but may be found at any time between February and December.

GW 55 Grey whales are frequently sighted throughout this area, particularly feeding on mysids among the kelp beds off Pachena Point. They may be found at any time between February and December.

GW 56-57 Grey whales are frequently sighted throughout this area, particularly off Clutus Point (area 61) where they feed on mysids in the kelp beds close to shore. They may be found at any time between February and December.

Sh 55 Gooseneck barnacles occur in abundance on Pachena Point.

K 55 Kelp beds occur sporadically along this portion of coastline.

H 54 Sensitive. This unit contains Heritage Site #146.

H 55 Highly sensitive. This unit contains Heritage Sites #147 - 149.

H 56 Sensitive. This unit contains Heritage Site #150.

SS 56 The Masit Indian Reserve is located in this area.

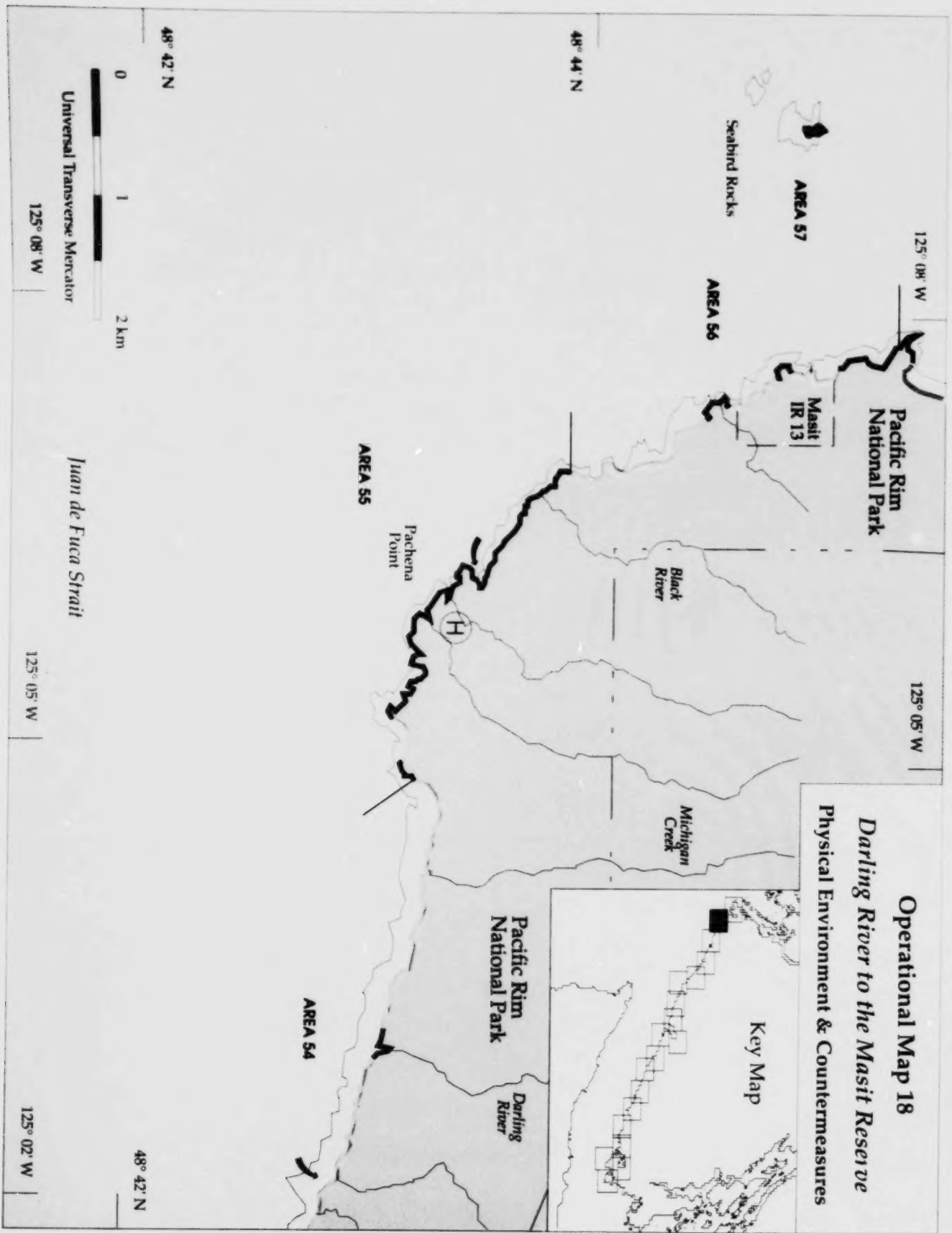
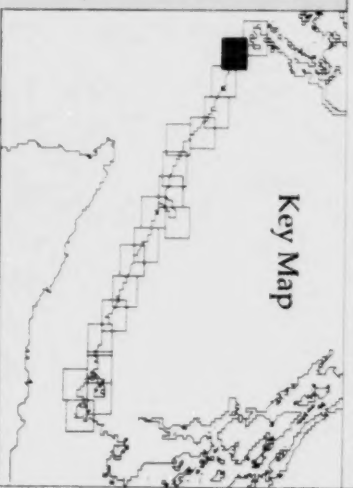
SS 54-57 Pacific Rim National Park.

Questions regarding specific areas of potential importance to shellfish harvesting must be referred to the Department of Fisheries and Oceans, South Coast Division.

In the case of an oil spill emergency, detailed information regarding native subsistence locations between Cape Beale and Christopher Point can be obtained from the bands through their chief councillors (see User's Guide).



Operational Map 18 Darling River to the Masit Reserve Physical Environment & Countermeasures



PHYSICAL ENVIRONMENT & COUNTERMEASURES

Operational Map 18 - *Darling River to the Masit Reserve*

Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

The West Coast Trail is remote from the shoreline in this area.

Marine landings are restricted by bedrock platforms and high waves. Shallow-draft vessels could approach the coast under favourable conditions at a small cove on Pachena Point, and at an unnamed pocket beach to the east.

Helicopter landings can be made at the Pachena Point Light House (Note: the landing area is removed from the shoreline).

COUNTERMEASURES

The wide bedrock platform restricts transport and cleanup options along the eastern segment of this section. Small dunal deposits above the narrow beach west of Orange Juice Creek are vulnerable to disturbance.

The mouth of the Darling River is the site of a small delta. The narrow cover of mixed sediment forming the backshore in this area could become oiled.

Although there is some apparent channelling in the delta, booming would not be feasible. Manual cleanup followed by bioremediation would be the most effective response.

A similar situation exists at the mouth of Michigan Creek where there is a deposition of mixed sediments associated with a wide bedrock platform (continuing to the west). A further response option for Michigan Creek involves flushing oil into the surf zone. Boat landings in this area would be even more restricted than at Darling River.

The rugged shoreline with bedrock platform continues to the headlands of Pachena Point where high sea states would quickly remove oil that impacts the coast. Cleanup would be extremely difficult in this area.

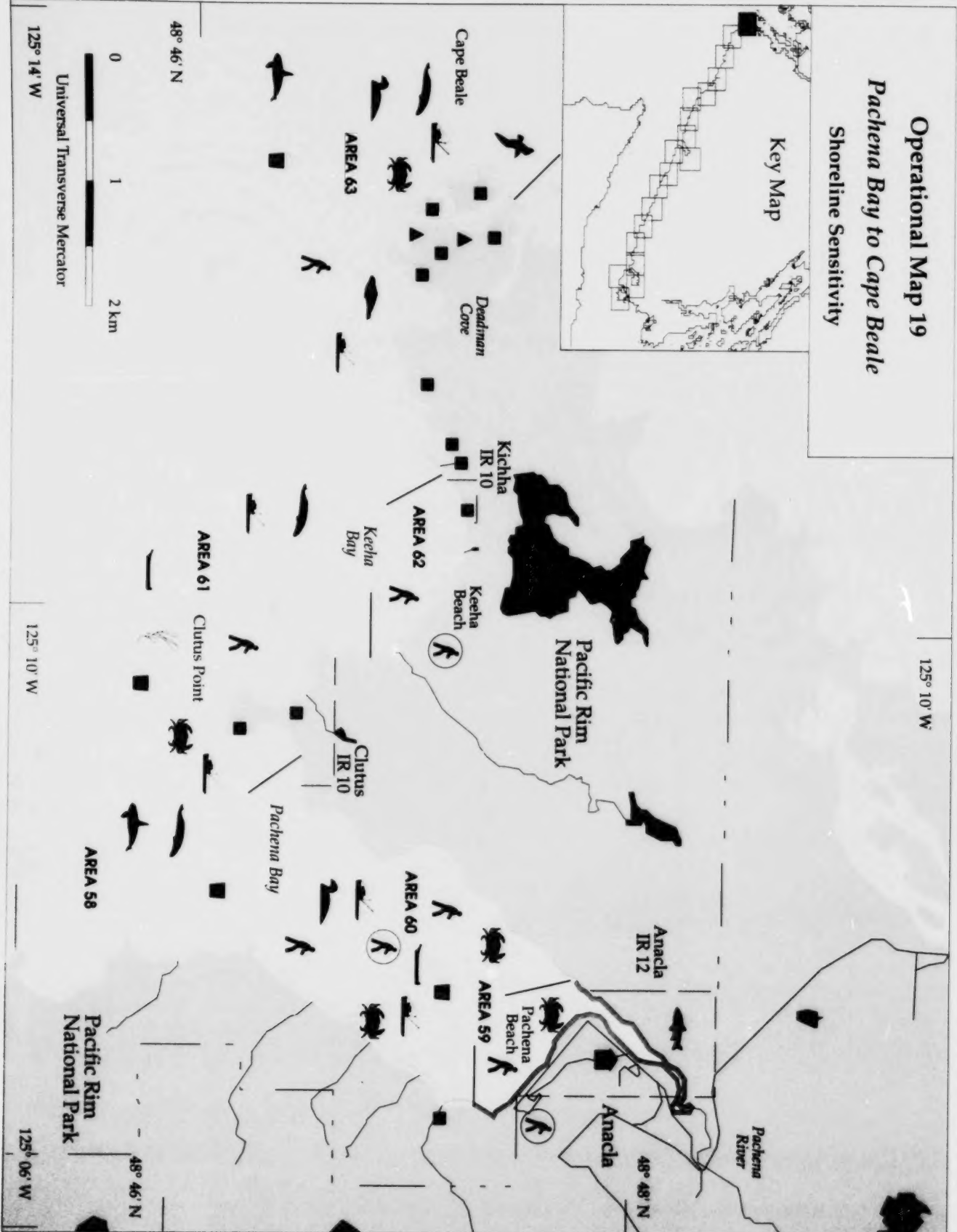
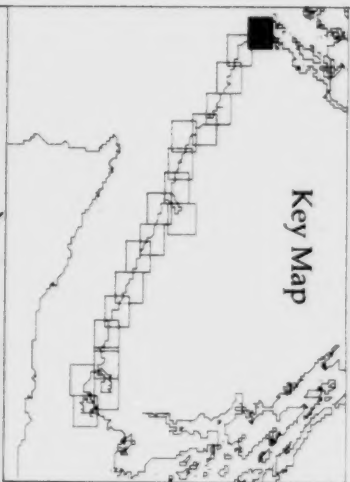
As the coastline turns to the north past Pachena Point, it continues to be steep and rocky with a bedrock platform and no beach. A narrow fringe of mixed sediments often backs the bedrock platform, particularly north of the Masit Indian Reserve. Oil persistence would be low along this shore. The isolated pocket beaches further west would be difficult to clean without a safe means of supporting clean-up crews.

The bird habitat at Sea Bird Rocks is well recognized. Disturbance to nesting birds will be an important factor in planning operations in this area.

Operational Map 19

Pachena Bay to Cape Beale

Shoreline Sensitivity



Environmental Description

Legend

Shoreline Sensitivity*

- Extreme Sensitivity Ranking > 45
- High Sensitivity Ranking 35-45
- Moderate Sensitivity Ranking 21-34.9
- Low Sensitivity Ranking < 21

* See Appendix A

No.	Name	Sensitivity Ranking
58	E Pachena Bay	26.5
59	Pachena River estuary	41.1
60	W Pachena Bay	25.2
61	Clutus Point	30.3
62	Keelha Bay	26.6
63	Cape Beale	33.2

	Community C		Harbour Seal HS
	Commercial Fisheries CF		Orca Or
	Recreation Local RL		Grey Whale GW
	Recreation Diffuse RD		Salmonid Spawning Sa
	Intertidal Harvesting SH		Shellfish Sh
	Offshore Harvesting SH		Kelp Beds K
	Many Birds B		Heritage Site High H
	Moulting Birds MB		Heritage Site Moderate H

C 59 There is a small community on the Anacila Indian Reserve.

CF 58-60 Commercial fishing for crabs occurs throughout Pachena Bay.

CF 58-63 A maximum of 750 commercial fishing boats per day fish for Chum salmon and a maximum of 100 commercial fishing boats per day fish for the other species of salmon from mid-September to mid-November in the area from Port San Juan to Cape Beale. One of the more popular spots is offshore of Cape Beale.

CF 58 Squid are harvested along the eastern shores of Pachena Bay.

CF 59-60 Clams are harvested from the shores of Pachena Beach.

CF 61-63 An average of 1-2 crab boats per day set traps throughout the year in the area from Port San Juan to Cape Beale.

CF 61 Goose-neck barnacles are occasionally harvested from the area around Clutus Point.

CF 63 Goose-neck barnacles and abalone are occasionally harvested in the vicinity of Deadman Cove and Cape Beale.

RL 59 Pachena Beach, which has a campsite, is used in the summer months.

RL 62 A wilderness campsite is located at Keelha Beach.

RL 63 A maximum of 50 boats per day fish for all species of salmon from June to September offshore of Cape Beale. Approximately 2 boats per day fish for Lingcod and rockfish in the summer months in the vicinity of Cape Beale.

RD 58-59 Hikers use the West Coast Trail; kayakers and divers use the marine area along the coast. Mussels and Goose-neck barnacles are occasionally harvested by hikers along the trail. Pachena Bay offers good anchorage for sailboats.

RD 58-61 Crab traps are occasionally set in the Pachena Bay area.

RD 62 Hikers use trails from the highway or Bamfield which lead to Keelha Beach.

RD 63 Hikers use trails from the highway and Bamfield which lead to Cape Beale.

RD 60-63 Divers use this area along the west coast which is known as the "Graveyard of the Pacific".

RD 58-63 Researchers and students from the Bamfield Research Station have occasional field trips to destinations

along the coast from Carmanah Point north to Barkley Sound.

SH 58-61 Both offshore and intertidal native subsistence harvesting occurs in these areas.

SH 63 Intertidal native subsistence harvesting occurs in this area.

B 63 High numbers of diving ducks are found around Cape Beale in fall, winter and spring. A colony of Pelagic cormorants (14 pairs) occurs off Cape Beale.

MB 58-60 Moulting concentrations of White-winged scoters (50 birds sighted) occur in Pachena Bay in July and August.

MB 63 Moulting concentrations of White-winged (600) and Surf scoters (150) occur off Cape Beale in July and August. Scoters are very vulnerable to oil spills at this stage due to their flightless state and tendency to stay on the water or at water's edge.

HS 63 Harbour seals haul out off Deadman Cove east of Cape Beale (35 seals).

Or 58-63 Transient pods of orcas may be found along the coast throughout the year.

GW 58-63 Grey whales are frequently sighted throughout this area, particularly off Clutus Point (area 61) where they feed on mysids in the kelp beds close to shore. They may be found at any time between February and December.

Sa 59 Coho and Chum salmon and Steelhead spawn in the Pachena River in the following numbers: Coho 3,500; Chum 1,500; and Steelhead 200.

A few hundred sea-run Cut-throat trout also spawn in the Pachena River, inhabiting the nearshore waters within the bay.

Sh 58-60 A summertime crab fishery occurs in Pachena Bay. Squid spawn on the east side of the Bay. Clams occur on the beach at the north end.

Sh 61 Goose-neck barnacles occur in abundance on Clutus Point.

Sh 63 Goose-neck barnacles occur in abundance.

K 61 Kelp beds occur sporadically along this portion of coastline.

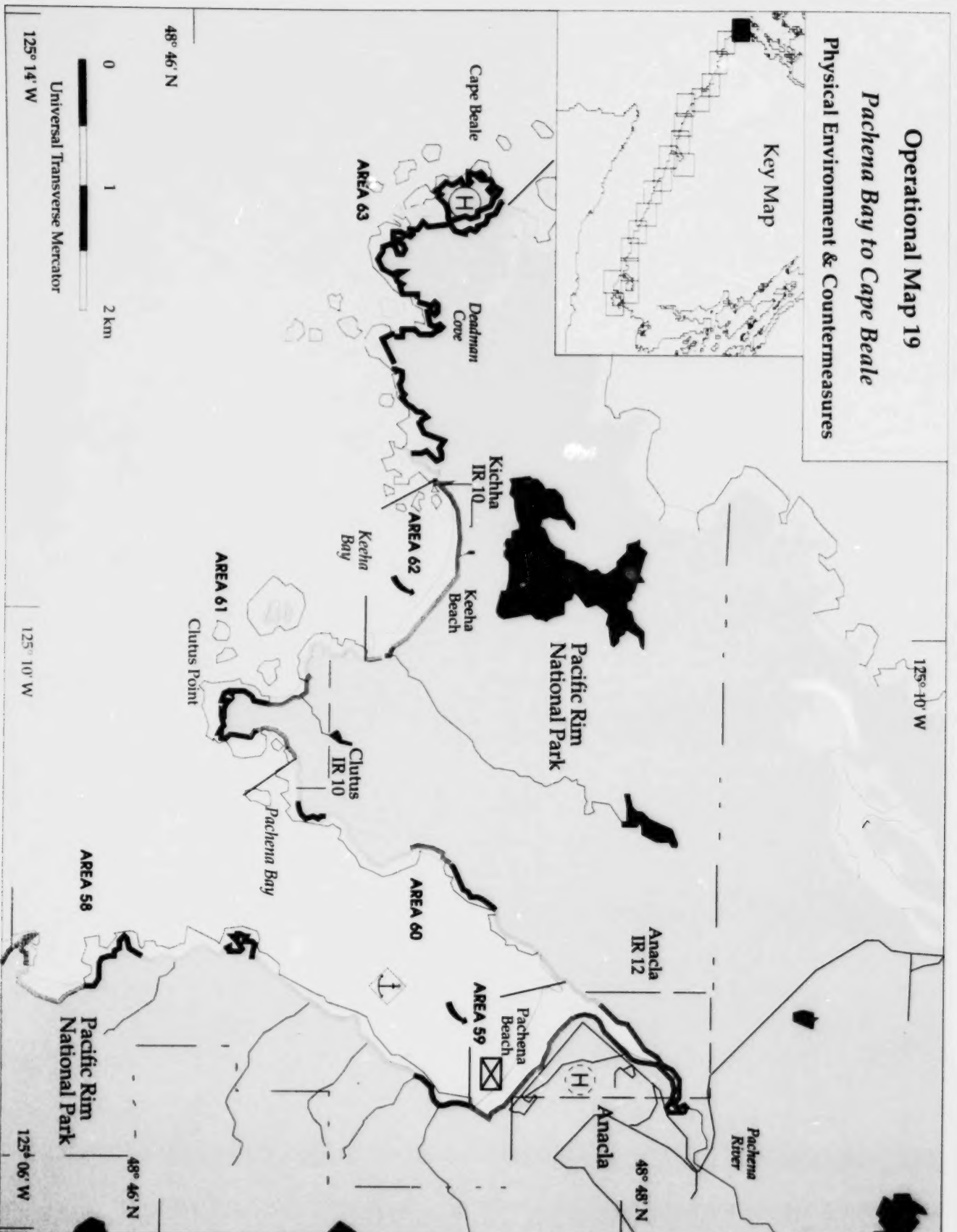
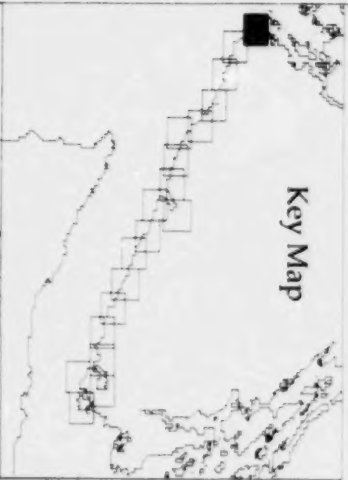
H 58 Sensitive. This unit contains Heritage Site #151.

H 61 Highly sensitive. This unit contains Heritage Sites #152 & 153.

H 62 Sensitive. This unit contains Heritage Site #154.

Operational Map 19 Pachena Bay to Cape Beale Physical Environment & Countermeasures

Key Map



Legend

	Cliff
	Cliff with Platform
	Cliff with Platform and Beach
	Headland/Pocket Beach
	Mixed Sediment Beach
	Sand Beach
	Intertidal Flats
	Estuaries
	Rocky Ledges/Reefs
	Foreshore Flats
	Staging Areas
	Access (Marine or Land)
	Anchorage
	Temporary Anchorage
	Helipad
	Helicopter Landing Site

ACCESS

Surface alternatives for reaching the shore in this area include the West Coast Trail and the highway to Bamfield.

Sea and conditions prevent safe vessel approaches along this stretch of coast. Pachena Beach and Keecha Beach are possible locations for shallow-draft vessel landings. A limited number of smaller pocket beaches would be acceptable depending on wave conditions. Pachena Bay, provides a relatively sheltered location for vessels, and the beach would be useful as a staging area.

Helicopter landing sites are located at Cape Beale and at Pachena Beach.

COUNTERMEASURES

The east side of Pachena Bay is characterized by a bedrock platform backed by a narrow veneer of mixed sediments. Water flushing could be used to remove and herd oil to booms and skimmers under calm conditions. Heavy equipment could be landed at the head of the Bay to assist in mechanical cleanup of stranded oil.

Cleanup operations would require careful monitoring to minimize disruption to intertidal organisms at the mouth of Pachena River, and to avoid damage to sand dunes in back-shore areas.

The bedrock and cliffs which dominate the northwest shore of Pachena Bay could be cleaned using water blasting (with prior regulatory approval). One approach could be to leave much of this shore to clean naturally. Exceptions are several sediment beaches which may be suited to flushing, booming, and skimming activities.

The pocket beaches toward Clutus Point could be cleaned using mechanical and manual methods (sea conditions permitting). Bioremediation could be considered as an optional response method.

Keecha Bay is more readily accessible; mechanical cleanup may be possible if heavy equipment can be landed on the beach using shallow-draft vessels.

Further west toward Cape Beale, sediment deposition along the shore zone becomes increasingly scarce, ultimately ending in the rocky headlands of the Cape. Stranded oil would not persist in this area except in occasional, localized sediment deposits located in the inner passage. Access is severely limited.

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SENSITIVITY RANKING SYSTEM

1.0 INTRODUCTION AND OVERVIEW OF SENSITIVITY RANKING SYSTEM

The sensitivity ranking system is composed of the following four major categories:

- human use
- biological resources
- shoreline oil residence
- special status areas

Each category is given a Weighting Factor between 1.5 and 2.0 as outlined.

Category	Weighting Factor
Human Use	2.0
Biological Resources	1.75
Shoreline Oil Residence	1.5
Special Status Areas	1.5

The human use category received the highest Weighting Factor to reflect the importance of protecting life styles, livelihoods, and property in the event of an oil spill (Dickins et al., 1987). Biological resources are both sensitive and vulnerable to oil, and their high Weighting Factor reflects the importance of biological resources along coastal British Columbia. The shore zone oil residence category and special status areas receive the same Weighting Factor.

Elements within each of four categories are ranked on a scale from 1 to 10 (although the entire scale may not be used for each category) based on estimates of their relative sensitivity to potential effects of oil spills. The most sensitive element in each category received an Assigned Value of 10.

The Assigned Values are modified for each category. The rationale for the modifications is described under the discussion for each category (see following sections). For example, the shore zone oil residence Assigned Values are modified to reflect the percentage of shoreline

length within each area that is associated with each different oil residence code.

Within each category, the modified Assigned Values are added for each area to produce a Total Assigned Value for the area. The Total Assigned Values are then normalized by dividing the Total Assigned Value for each area by the maximum Total Assigned Value for all areas and multiplying by a factor of ten. The Normalized Assigned Values for each category range from 1 to 10.

Normalizing the Assigned Values within each category ensures that categories with more elements do not outweigh categories with fewer elements in the final sensitivity ranking. The relative importance of each category is reflected by the Weighting Factors. The choice of values for these factors is extremely subjective; the numbers shown in Table A1 follow the ranking systems used in previous atlases for the Beaufort Sea and Lancaster Sound.

The relative sensitivity of each shoreline area is determined by multiplying the Normalized Assigned Value and Weighting Factor for each category to produce a Priority Index. The sum of all the Priority Indices for each area is then used to define the sensitivity of that area to an oil spill (relative to all other shoreline areas within the atlas boundaries).

The following equations illustrate the procedure for calculating the priority indices:

$$PI = NAV \times WF$$

where PI = Priority Index

NAV = Normalized Assigned Value

WF = Weighting Factor

and

$$S = \Sigma PI$$

where S = Sensitivity of an area to an oil spill

In the final map presentations, the sensitivity rankings of each area are divided into four degrees of sensitivity (EXTREME, HIGH, MODERATE, and LOW) to allow for rapid determination of the relative sensitivity of an area in the event of an actual oil spill.

2.0 DESCRIPTION OF CATEGORIES

2.1 Human Use Category

The human use category incorporates the following elements:

- communities
- native subsistence harvesting
- commercial nearshore fisheries and aquaculture
- tourist industries
- commercial industries
- recreation, localized
- recreation, diffuse

Table A1 lists the elements and their Assigned Values.

Table A1	
Element	Assigned Value
Communities	10
Native Subsistence Harvesting	
- most important	10
- important	8
- less important	6
Commercial Fisheries & Aquaculture	8
Tourist Industries	7
Industries	5
Recreation	
- localized	4
- diffuse	2

The Assigned Values are based on the vulnerability of the resource or activity to an oil spill (direct or indirect) and whether the potential impact of a spill is long term (one season or more) or short term (less than one season or a one-time event). The potential impact may be

actual or perceived.

No attempt was made to attach relative economic values to human use elements for ranking purposes. While a log boom has a dollar value based on its market value, it is very difficult to assign a realistic dollar value to activities such as hiking.

Overall, economic activities are ranked higher than pure recreational activities. Economic activities include native subsistence harvesting, commercial fisheries (nearshore only), aquaculture, tourist industries, and other industries (e.g., fish processing, logging).

Where several of the same elements occur within one area the Assigned Value is modified by increasing it by 1. For example, where more than one diffuse recreational activity occurs in an area, the Assigned Value is modified from 2 to 3. This simple approach adds extra weighting for abundance within an element but maintains the relative position of one element to another.

2.1.1 Communities

Communities are given the highest Assigned Value (10) as these areas are of great importance to local residents and are inhabited year-round. The importance of the shoreline to a community can reflect a multitude of uses, both commercial and private, as well as its intrinsic aesthetic value. Perception of the potential impact of an oil spill on a community may actually exceed the real impact; however, public perception is often the main driving force behind oil spill response (Harper, 1985).

2.1.2 Native Subsistence Harvesting

Native subsistence harvesting information was gathered specifically for this study and is described here in detail. The results of the survey are confidential and the maps only indicate whether offshore fishing or intertidal gathering occur within a sensitivity area. The maps do not indicate the number or location of sites or the species harvested. Although offshore subsistence fisheries are included in the survey results, they are not mapped or ranked here unless fishing occurs within 1 to 2 km of shore (nearshore fishing). This is consistent with

the treatment of commercial offshore fisheries (this atlas is limited to the coastline and immediately adjacent waters).

Native subsistence use of marine and shoreline resources was identified as a major gap in the data compilation of the Coastal Atlas for the Southwest Coast of Vancouver Island. The information presented here was gathered to ensure that native subsistence use of these resources is considered in the event of an oil spill emergency off the southwest coast of Vancouver Island.

Subsistence harvesting information was collected directly from native Indian bands within the boundaries of the Atlas and recorded in note form, on tape (where possible), and on 1:50,000 NTS maps. This data was compiled and presented in a Subsistence Resource Directory and a confidential Summary Data File for each band for use in an oil spill emergency.

Objectives

The subsistence harvesting component of the atlas had three objectives:

- to record information on current native subsistence use of marine and shoreline resources
- to compile and map these data sets on 1:50,000 NTS maps
- to compile collected data into Subsistence Resource Directories and confidential Summary Data Files for each band residing within the Atlas boundaries

Subsistence Use Ranking

A subsistence use ranking system was developed such that on-scene personnel can assign priorities to protect these locations in the event of an oil spill. Sites were rated according to their contribution to the overall subsistence pattern of the bands.

The process of ranking specific resource locations depended on the following factors:

- quantity of food extracted from resource location
- seasonal or year-round use of resource location
- range of subsistence species extracted from resource location
- relative ease with which the resources extracted can be stored for later consumption
- distance of resource location from band members' residence
- exposure of site to prevailing weather conditions

All of these factors were important in developing a three-tiered ranking system, with a numerical value of "3" assigned to the most important resource locations.

The following definitions were used to categorize different sites in terms of relative importance:

Rank 3

Definition:

Most important site for subsistence food collection for native consumption.

Description:

The most important subsistence locations were all major fishing sites. These were given a ranking of "3". Fish, both marine and stream were identified by all bands as the most important subsistence food resource to the band's members. From the interview process, it is clear that fish (salmon, halibut, lingcod, red snapper and other rockfish) comprise well over half of the total food value of all subsistence resources. Seasonal extraction of salmon from rivers is particularly important, although capture of salmon and other fish offshore continues throughout the year.

Many different species of fish are available on a continuous basis. The large quantities of salmon netted in rivers or caught offshore are smoked or canned for later consumption. All bands have excellent fishing locations close at hand to their reserves, although some of them cannot be used during inclement weather.

Rank 2

Definition:

Important site for subsistence food collection for native consumption.

Description:

Intertidal and subtidal gathering locations, duck hunting locations, shrimp collecting locations, and one deer hunting location were all given a ranking of "2". These sites, although important to the overall diet of individual families, contribute substantially less quantity of food than fish. This ranking is also given to offshore or stream fishing locations that are not heavily used. Most of these sites are used only seasonally. A wide variety of species are being extracted at the intertidal and subtidal resource locations (chitons, gooseneck barnacles, urchins, crabs, shellfish). However, in no instances are large quantities of any one species being taken from any location. Most of these resource locations yield species for immediate consumption, rather than later use. Locations preferred tend to be those that are closest to the reserves and relatively accessible during inclement weather. In general, these locations yield more food more easily than locations with a ranking of "1".

Rank 1

Definition:

Less important site for subsistence food collection for native consumption.

Description:

Resource locations given a ranking of "1" include all locations

where subsistence use is either infrequent or quantities taken are small. For example, sites where few band members extract a single resource species fall into this rank. Locations where it was described that several species were being extracted from a large geographical area are also included here. Generally, these sites tended to be far from the reserves or difficult to access during inclement weather.

The sites designated as most important for subsistence food collection (Rank 3) are given an Assigned Value of 10. These sites are ranked the highest (equal with communities) due to their vulnerability to oil spills and their economic and cultural importance. Sites designated as important (Rank 2) are given an Assigned Value of 8. Sites designated as less important for subsistence food collection are given an Assigned Value of 6. The Assigned Value for each sensitivity area is determined from the sites (for both intertidal harvesting and nearshore fishing) with the highest rank, although more than one subsistence harvesting site may occur within each area.

Table A2
Distribution of Subsistence Sites Between Different Bands

	Rank 3	Rank 2	Rank 1	Total
Beecher Bay Band	1	7	2	10
Sooke Band	2	6	7	15
Pacheenaht Band	5	12	7	24
Ditidaht Band	6	10	8	24
Ohiaht Band	2	5	2	9
Totals	15	41	26	82

Summary

- A total of 82 native subsistence resource locations were identified and mapped on 1:50,000 NTS maps.
- Information from these sites was compiled into a Subsistence Resource Directory and Summary Data Files for

each band. This data is confidential. In the event of an emergency details about specific sites at risk can be obtained from the Provincial Government and individual band members (see User's Guide at the front of this atlas for contacts).

2.1.3 Commercial Nearshore Fisheries and Aquaculture

Commercial fisheries and aquaculture have an Assigned Value of 8. They are very vulnerable to oil spills and the potential impact of a spill may be long term (more than one season) as the fishery may not be able to be re-established at that location. Commercial fisheries considered here are nearshore fisheries and shellfish harvesting (abalone, geoduck, sea urchin, sea cucumber, prawns, crabs, shrimp, and squid), and do not include offshore fisheries. Commercial fisheries data are gathered over broad areas and are not site-specific. Data on commercial harvesting of geoduck, abalone, and red urchins have been collected by the Department of Fisheries and Oceans but are confidential.

2.1.4 Tourist Industries

Tourist industries are ranked higher than commercial industries with Assigned Values of 7 and 5, respectively. Tourist industries include marinas, tourist lodges, trailer parks, boat charters, and organized tours (such as wildlife viewing tours). Sports fishing locations are considered under recreation. The businesses that directly depend on sports fishing (marinas, boat charters, motels, etc.) are included in the tourist industry.

Tourism tends to be a seasonal industry; however, it is a rapidly growing industry in British Columbia and many businesses are busy year-round. The livelihood of people involved in the tourist industry depends on the presence of biological resources as well as shoreline and offshore use and access and preservation of the area's aesthetic value. These resources are vulnerable to an oil spill and the duration of the impact may be long term (more than one season). Even though the potential impact of a spill may be perceived rather than actual, the public perception that an area's aesthetic or recreational value is lowered will result in a negative impact on the tourist industry.

2.1.5 Commercial Industries

The main commercial industries in the study area include commercial fishing and forestry. Offshore fisheries are not included in the scope of this study and nearshore fisheries are considered separately with aquaculture sites. Fisheries are accounted for indirectly in this section by including government wharves, fish processing and packaging plants as commercial industries. The impact of an oil spill to the operation of fish processing and packaging plants is indirect and short term as it mainly affects the operation of the wharf for unloading commercial fishing catches. The potential long term impact to fisheries related industries is reflected in the higher Assigned Value given to nearshore commercial fisheries.

Forestry facilities include sawmills, dry land sorting yards, and log booming areas. Of these facilities, only log booming areas will be directly affected by an oil spill and the potential impact is likely to be short term (one time event).

2.1.6 Recreation

Recreation is divided into two categories. Localized recreation includes activities or resources such as beaches, campsites, sports fishing (specific areas), scuba diving, and wildlife viewing. Diffuse recreation includes activities such as sports fishing (broad areas), hiking, kayaking, and sailing. Their Assigned Values are 4 and 2, respectively. Localized activities are more vulnerable (being less widely distributed) to an oil spill and its cleanup operation than activities that occur over a wider geographical area. Recreation activities along the coast are most intense during the summer months (May to October); however, many activities occur year-round or have a longer season.

The potential impact of a spill on recreation activities is long term (one season or more). As with tourism, an overall public image of a damaged wilderness area may reduce the regional attraction of the entire west coast of Vancouver Island.

Localized and diffuse recreation includes activities that occur at both designated and non-designated public sites. Designated public sites (national, provincial, regional, community parks and forestry sites) are

given additional priority as special status areas which receive an independent ranking.

2.2 Biological Resources

2.2.1 Overview of the Biological Sensitivity Ranking Method

The assessment of the relative biological sensitivity of the Environmental Sensitivity Areas (ESA's) consisted of the following steps:

- The major biological resources or "elements" which occurred in the study region were identified.
- The vulnerability and short-and long-term sensitivity of each element to oil spills were characterized and used to derive "relative sensitivity" values.
- The abundance, distribution and seasonal occurrence of each element in the study region were determined from existing published and unpublished data. This information was used to develop "relative abundance" values for each element.
- For each biological element that occurred in an ESA, a biological sensitivity value was derived based on its relative sensitivity and abundance values. A total biological sensitivity rating for the ESA was calculated by summing the biological sensitivity values for all elements that occurred in it and multiplying it by the biological sensitivity weighting factor.

Section 2.2.2 discusses the general method used for determining relative sensitivity and abundance values. The choice of biological elements for the study region is detailed in section 2.2.3, and sections 2.2.4 and 2.2.5 describe the generation of sensitivity and abundance values for these biological elements specifically.

Data Limitations

Most of the southwest coast of Vancouver Island is remote and exposed, and is generally thought to be less productive biologically than other parts of the coast. In addition, it is considerably more difficult to study than other, more accessible coastal areas. As such, data on the distribution and abundance of most biological resources are sparse in comparison with data resources for other parts of the coast of B.C. Particular deficiencies in the biological data pertaining to this study are as follows:

- *Marine birds:* Estimates of regional populations and relative abundance values are based in most cases on data from relatively few surveys of wintering and migrating bird populations. Most surveys were by airplane, which means that species that are difficult to see from the air are likely underestimated. In particular, data are absent for pelagic species such as Common Murres, which are known to form very large flocks during migrations off much of Vancouver Island.
- *Seals and sea lions:* Sea lion populations have been fairly extensively studied from surveys of haulout sites. Harbour seal abundance and distribution are estimated on the basis of numbers surveyed on summer haulout sites when low daytime tides allow easy visibility of the animals from the air. It can only be assumed that these results reflect abundance and distribution for the rest of the year. Other marine mammals are known to visit the study region but could not be included due to infrequent occurrence or lack of distribution and population data.

- *Whales:* Whale populations are difficult to quantify on a regional basis due to their tendency to move over very large distances. Existing distribution data is based largely on records of individual sightings as opposed to systematic surveys, such that distribution in the study region can be described only in a qualitative manner. Sufficient records exist only for orca and grey whales. Other cetaceans

(porpoises, humpback and minke whales) occur in the study region but in such small, dispersed groups or at such distances offshore as to make surveys unfeasible.

- *Fish:* With the exception of salmon escapement records and herring spawning surveys, there are virtually no population and distribution data for fish or shellfish in this area. Areas of known present use by commercial, recreational and subsistence fisheries are the main indicators of abundance of these organisms, but this largely overlooks areas inhabited by unexploited populations along with areas of importance such as breeding and rearing habitat which in all likelihood are more sensitive to oil contamination.

- *Biological productivity:* Estimating relative biological productivity on the basis of physical shoreline types is only as accurate as the assumptions made about their relative productivity. For instance, "estuaries" and "intertidal flats" are assumed to be the most productive shoreline types. A section of shoreline is classified as either one of these types based on certain physical characteristics, but it may or may not be highly productive due to a variety of features that are not taken into account in the classification system.

The overall approach taken here to cataloguing biologically sensitive areas suffers from a lack of detailed site and season-specific data. These limitations must be kept in mind in any application of this biological rating system.

2.2.2 Methodology

Estimating Relative Sensitivity (RS) for Each Biological Element

The relative sensitivity of each element to the effects of oil was determined by considering 4 factors:

- *Vulnerability (V)* - the likelihood of the element contacting oil, given the species' behaviour patterns (e.g., feeding, breeding, resting) and distribution pattern (whether individuals are

dispersed or tend to congregate).

- *Sensitivity type 1 (S1), sublethal* - the potential to suffer physical or behavioral effects that do not cause direct mortality but may have detrimental effects on growth, survival and/or reproduction.
- *Sensitivity type 2 (S2), lethal* - the potential for mortality to occur as a direct result of oil contact. The potentials for both sublethal (S1) and lethal (S2) effects were estimated from available information from past marine oil spills and laboratory and field research reported in the literature.

- *Recovery period (R)* - an indication of the length of time required for the population or community to recover from the effects of oil contact. This factor takes into account reproductive capacity (fecundity, time to maturity, and population size) and the potential for recruitment or re-establishment by immigration.

Table A3 indicates how V, S1, S2 and R were described and quantified on a scale of 1 to 5 for each biological element. Applying these descriptors to the biological elements required some subjective judgement, but designations were verified in the literature or with experts as much as possible.

Table A3
Descriptors and Assigned Values for V, S1, S2, R

Descriptor for:	R	Value
V, S1, S2		
Very low		Very short = 1
Low		Short = 2
Moderate		Moderate = 3
High		Long = 4
Very high		No recovery = 5

Relative Sensitivity (RS) was then calculated for each element by the equation:

$$RS = (V \times 2) + S1 + S2 + R$$

Note that greater emphasis was placed on the vulnerability of biological resources to oil to ensure that the relative sensitivity was not over-weighted for a population that may be particularly sensitive to the toxicity of oil but is unlikely to contact oil because of the nature of its distribution or life strategy.

Estimating Relative Abundance (A) for Each Biological Element

Relative abundance (A) of a given element in a given ESA was determined on the basis of 3 factors:

- *Relative regional abundance (RA)* - measure of the element's abundance in the ESA relative to its total abundance in the study region. Values of RA range from 1 to 5 on the following basis:

- 5 = a "significant portion" of the population in the study region is present in the ESA
- 3 = the element is present in the ESA but in less than significant numbers
- 1 = very low numbers of the element are present in the ESA

What comprises significant, less significant and low abundance is a function of the population characteristics of the element and as such was determined independently for each element.

- *Seasonal modifier (SM)* - indicates the amount of time the element is present in the study region. SM values ranged from 0 to 1 depending on what proportion of the year it is present in the study region. A season was defined as 0.25 year, and elements were typically characterized as present for 1 (0.25), 2 (0.5), 3 (0.75) or 4 (1) seasons. Seasons were defined as:

Winter - December to February (inclusive)
 Spring - March to May
 Summer - June to August
 Autumn - Sept to October

- *Regional importance modifier (IM)* - indicates the importance of the element's population in the study region relative to the total population in B.C. or the world. Biological elements were assigned IM values of:

3 = a "significant proportion" of B.C.'s and/or the world population is present in the study region at some time, or the element is rated as endangered, threatened, or vulnerable by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, 1987)
 1 = the element is present in the study region in less than significant numbers and is not threatened or endangered

Relative Abundance (A) of each element that occurs in an ESA was then calculated by the following equation:

$$A = RA \cdot SM \cdot IM$$

Estimating Biological Sensitivity for Environmental Sensitivity Areas

For each ESA, an "Assigned Value" (AV) was calculated for each biological element that occurs in that area by:

$$AV = RS \cdot A$$

where RS = relative sensitivity value for the element
 A = relative abundance value for the element

The overall biological sensitivity value for the ESA was then derived by summing the AV's for all elements occurring in the area and multiplying the sum by the biological sensitivity weighting factor (1.75):

$$\text{Biological Sensitivity Value for ESA} = \Sigma AV \times 1.75.$$

2.2.3 Selection of Biological Elements

Selection of the biological elements was based on biological, social, and economic importance. Information on these factors was gathered from the literature and from discussions with specialists in the field. The biological elements fall into 4 representative groups: marine birds, marine mammals, fish and shellfish, and biologically productive nearshore habitats.

Marine Birds

Three general categories of marine birds were identified on the basis of their use of the study region: those that breed, those that form summer moulting concentrations, and those that migrate through or overwinter in the study region. Nine different groups were distinguished as encompassing the major marine bird species in the study region (Table A4).

Table A4
 Important Bird Groups and Species in the Study Region

Category	Group	Major Species or Sub-Groups Considered
Breeding	Alcids ¹	Pigeon Guillemot, Cassin's Auklet, Rhinoceros Auklet, Tufted Puffin
	Petrels	Fork-tailed Storm Petrel, Least Storm Petrel
	Divers	Pelagic Cormorants, Brandt's Cormorants
	Shorebirds	Black Oystercatcher
	Gulls	Glaucous-winged Gull
Moulting	Diving Ducks	White-winged Scoter, Surf Scoter

Table A4
(continued)

Category	Group	Major Species or Sub-Groups Considered
Migratory or over- wintering	Divers	Pelagic Cormorants, Brandt's Cormorants, grebes, loons
	Diving Ducks	White-winged Scoter, Surf Scoter, Black Scoter, Bufflehead, Barrow's and Common Goldeneye, Harlequin Duck, Red-breasted Merganser
	Shorebirds	[Species of subgroups not distinguished in available distribution data, but would include species of sandy shorelines (e.g., Dunlin, Western Sandpiper, Sanderling, Semi-palmated Plover) and of rocky shorelines (e.g., Black Turnstone, Rock Sandpiper, Surf-bird, Black Oystercatcher).]
	Dabblers, geese, and swan	Mallard, American Wigeon, Green-winged Teal, Brant, geese, Trumpeter Swan
	Gulls	[Species of subgroups not distinguished in available distribution data, but would include Glaucous-winged, Herring, Bonaparte's, Mew Gull.]

¹Other Alcids (e.g., Common Murre, Marbled Murrelet) occur in the study region, but no distribution data are available.

Although other species are known to occur in the region, they are found in very low densities or distribution data are not available for them. This is particularly true for non-breeding alcids. For example, from mid-July through September, flocks of up to 10,000 Common Murres, adults and young of the year, move up the coast from colonies in Oregon. Another major movement occurs in September and October by birds arriving from colonies in Alaska (Campbell *et al.*, in press; Hatter *et al.*, 1978). Large concentrations also form off the coast in winter; 5,000 murres were sighted

off Race Rocks in December (Campbell *et al.*, in press).

Similarly, Rhinoceros Auklets undergo a synchronous moult in late August or early September and accomplish migration mostly by swimming to wintering areas off Oregon and California (*ibid.*). In addition, Marbled Murrelets are found throughout the study region in spring and summer, but nesting sites have not been located (*ibid.*). These species are highly vulnerable to oil spills, as evidenced by the Nestucca spill in December, 1988 (Rodway, *et al.*, 1989). However, other than for breeding colonies, population and distribution data are lacking for these species in this region and therefore, they could not be accounted for in this study.

Bald eagles and crows also use the coastal environment on a regular basis. Being opportunistic feeders, they forage extensively on beach carrion (McTaggart-Cowan and Guiget, 1978; D. Dunbar and R. Taylor, pers.comm.). As such, they are susceptible to ingesting oil from contaminated birds and mammals washed up on beaches or on contaminated intertidal food organisms. However, crows are generally ubiquitous to coastal B.C. and regional populations are not known (*ibid.*). Winter surveys are conducted annually for Bald eagles for much of the province (Farr and Dunbar, 1988), but due to its remoteness, the southwest coast of Vancouver Island has not been covered. Consequently, these species were not included as biological elements. Instead, the "nearshore biological productivity" element (see following) was relied on to reflect areas of potential importance to these species.

Marine Mammals

Harbour seals, Steller and California sea lions, grey whales and orca (killer whales) were chosen as biological elements due to their abundance in inshore areas of southwestern Vancouver Island.

Harbour seals: Harbour seals inhabit the study region year-round, and although local movements occur in association with breeding and feeding, they are otherwise non-migratory. The species is traditional in the use of particular sites as haulouts in summer, and are typically seen in small groups resting on tidal reefs and sandbars at these sites. They

do not congregate in breeding colonies or rookeries but breed throughout most of their range (Olesniuk and Bigg, 1988).

Sea lions: Two species of sea lions, Steller and California, inhabit traditional haulout sites in the study region. Total populations of both species vary seasonally. Stellers arrive on the sites in fall, but total numbers of sea lions peak in winter with the arrival of California sea lions. In spring, California sea lions leave for rookeries in Oregon and California while most Steller sea lions disperse to rookeries in northern B.C. and Alaska (Bigg, 1984; 1985). There are no rookeries in the study region, but one haulout site is used by Steller sea lions year-round.

Grey whales: Grey whales are sighted regularly within 1-2 km of shore in the study region. Approximately 18,000 grey whales migrate along the eastern Pacific coast (NOAA, 1988), but only 20-50 animals are thought to travel in inshore areas at any given time (M. Bigg, pers.comm.). A few whales are found all year in the study region, but most are in transit to and from feeding grounds in Alaska and breeding areas in California and Mexico. Peak numbers occur during these migrations in fall and spring.

Orca: Two distinct populations of orca occur in the study region: resident and transient populations. The resident population is made up of 3 pods consisting of 83 animals. These pods travel primarily around southwestern and eastern Vancouver Island and tend to move through the study region with few long stops. There are about 75 "transient" whales that frequent the region, and while they range more widely than resident pods, they tend to linger in bays and inlets (M. Bigg, pers.comm.).

Other marine mammals are known to visit these waters but were not included due to their infrequent occurrence in the study region or the lack of adequate distribution and population data. Northern elephant seals are known to haul out on Race Rocks during northward migrations, but their presence is uncommon (Olesniuk and Bigg, 1988). Northern Fur Seals are occasionally sighted in straits and inlets during migrations between Alaska and California, but the majority stay 15 km or more offshore (*ibid.*).

Dall's and Harbour porpoises are fairly common in inshore waters, but their distribution is so widespread and difficult to survey that determining specific areas of significance to them is not feasible (M. Bigg, pers. comm.). Other cetaceans (e.g., humpback and minke whales) are known to travel through the study region but spend the majority of their time offshore. Sea otters occur off the northwest coast of Vancouver Island but have not been recorded in the study region.

In addition, a number of terrestrial mammals use the coastal environment on a regular basis. Mink and River otter are the most common mammalian inhabitants of coastal areas in the study region, feeding primarily on crabs (K. Atkinson, pers.comm.). Raccoons also feed on a variety of small crustaceans and mollusks (McTaggart-Cowan and Guiget, 1978). Black bears frequent estuaries in early spring to take advantage of the fresh vegetation, and also forage on shellfish along the beach and on salmon during spawning seasons. Black-tailed deer also feed on fresh vegetation just above the high water mark, and may feed on washed-up seaweed (K. Atkinson, pers.comm.). Wolves are also found in the area, and likely feed on beach carrion.

These animals are susceptible to ingesting oil from contaminated birds and mammals washed up on beaches or on contaminated intertidal food organisms. However, these species are ubiquitous and their distributions along coastal B.C. are poorly known (*ibid.*). Consequently, these species were not included as biological elements. As with crows and Bald eagles, the "nearshore biological productivity" element was relied on to reflect areas of potential importance to these species.

Fish

Three elements are defined under this group: salmon, herring and shellfish.

Salmon: Seven salmonid species occur in marine waters in the study area: the 5 Pacific salmon (*Oncorhynchus* sp.: chinook, coho, chum, pink, and sockeye) as well as steelhead and sea-run Cut-throat trout (*Salmo* sp.). Coho and chum are the most abundant throughout the study area in terms of spawning populations, but relative abundances differ among spawning streams. Adult salmon concentrate at the mouths of rivers

during spawning seasons, which range from late July to October for the 5 Pacific salmon, and from January to May for steelhead. Juvenile salmon rely on estuarine and nearshore areas of the coast as rearing and feeding grounds, spending a few weeks to a few months in these areas, depending on the species (N.B. Hargreaves, pers.comm.).

Sea-run Cut-throat trout inhabit protected nearshore waters typically within 1-2 km of freshwater influence. This species prefers cobble beaches, and tends to stay within 5-10 m of the surf zone (P. Law, pers.comm.). Adults concentrate at spawning rivers in August, migrating upstream with the fall rains. Juveniles are concentrated in estuaries from mid-April to early June before dispersing to nearshore areas (*ibid.*).

Herring: Like salmon, herring are a vital fishery resource and are highly dependent on nearshore habitats during spawning season when herring eggs are laid in concentrations close to shore or in kelp beds.

Shellfish: Distributions of most shellfish species are not well documented for this section of the B.C. coast. Distribution data used here largely reflect sites of present commercial, subsistence or recreation use (Harbo and Hollingshead, 1988; Shoreline Archaeological Services Inc., 1990) or sites that are presumed to exist based on available knowledge (LGL Limited, and Environmental Sciences Limited., 1980; Jamieson and Francis, 1986; A.C. Phillips, pers.comm.). This overlooks areas of unexploited populations as well as areas of recruitment and juvenile habitat.

Given the available data, the following shellfish elements were defined based on distributions of the species noted:

- intertidal - clams, gooseneck barnacles, mussels.
- benthic subtidal - crab, urchins, geoducks, abalone.
- pelagic - shrimp, squid.

There is little data on the local distributions of non-commercial fish and shellfish species or on groundfish distributions. Areas important to these species can therefore only be inferred from coastal biophysical features that are indicative of high productivity or good habitat for these species. The category "nearshore biological productivity" has been created to take these areas into account (see following). Aquaculture operations (salmon,

mussels and oysters) are not included as they are considered under the "Human Use" sensitivity index.

Nearshore Biological Productivity

Intertidal areas can support rich biological communities which possess ecological value as well as support commercially and recreationally important species. A method was developed to indicate nearshore biological productivity of these areas on the basis of the physical shoreline types defined elsewhere in this study (see section 2.3 of this Appendix). The shoreline types used to indicate nearshore biological productivity are summarized in Table A5. These types represent combinations of substrate, exposure and slope commonly used to characterize biological communities and their relative productivity (Ricketts and Calvin, 1968; Fisheries and Environment Canada, 1978).

Table A5
Shore zone Types Used as Elements in the Nearshore
Biological Productivity Category

Shore zone Type	Relative Productivity
Estuary	very high
Intertidal flat:	
- mud-sand, low energy	high
- mixed sediment, moderate energy	mod-high
Mixed sediment beach:	
- protected	moderate
- not protected	mod-low
Sand beach, protected	low
Cliff/platform/beach	mod-low
Cliff	low

Estuaries are among the most highly productive natural systems and are vitally important as rearing habitat for many invertebrate and fish species (Odum, 1971; Ricketts and Calvin, 1968). Intertidal sand or mud flats have high organic content, are rich with burrowing organisms and are usually

associated with eelgrass beds which provide habitat for marine organisms (Ricketts and Calvin, 1968). Mixed sediment shorelines are inhabited by a variety of surface and burrowing organisms. Cliff/platform beaches are characterized by an abundance of anchored algal and tidepools that support a variety of invertebrate organisms. Other shore zone types defined in section 2.3 are not devoid of biological production but were considered of less significance.

Another factor worth considering in terms of biological productivity is the presence of kelp and eelgrass beds in intertidal and subtidal zones. Both provide important feeding and rearing habitat for a host of birds, fish and crustacea as well as contributing to the overall productivity of nearshore areas. Unfortunately, no comprehensive surveys have been conducted of eelgrass beds in this region. A kelp survey has been recently completed (Sutherland, 1988) but covers only the section of the study region from Race Rocks to Nitinat Narrows. In order to maintain consistency throughout the study region, kelp beds were not considered in rating ESAs for biological productivity, but their occurrence is noted in the maps and accompanying descriptions of the study region.

2.2.4 Vulnerability and Sensitivity of Elements to Oil

Table A6 indicates the vulnerability (V), sensitivity (S1 and S2) and recovery time (R) ranks assigned to each biological element. The following text provides a rationale for these assignments.

Table A6
Relative sensitivity ratings for biological elements.
(See Table A3 for derivation of V, S1, S2 and R values)

Element	V	S1	S2	R	RS
<i>Marine birds:</i>					
Alcids	5	4	4	4	22
Diving ducks	4.5	4	4	3	20
Divers	4.5	4	4	3	20

Petrels	3.5	4	4	4	3	19
Shorebirds	3.5	4	4	4	2	17
Gulls	3.5	4	4	4	2	17
Dabblers and geese	2.5	4	4	4	2	15
Trumpeter swan	2.5	4	4	4	4	17

Marine mammals:

Seals	4	4	2	2	2	16
Sea lions	4	3.5	2	2	2	15.5
Grey whales	2.5	2	1	1	4	12
Orca	2.5	2.5	1	4	4	10.5

Fish:

Salmon	4	4	4	4	3	19
Herring spawn	5	4	4	4	3	21
Shellfish:						
- intertidal	5	5	5	5	3	23
- benthic	3.5	4	4	4	3	18
- pelagic	2	4	4	4	3	13

Nearshore biological productivity:

	V	S1 & S2	R	RS
Estuary	5	10	5	25
Intertidal flat:				
- mixed sediment, moderate energy	5	5	2	17
- mud-sand, low energy	5	3	3	16
Mixed sed. beach:				
- protected	5	5	5	20
- not protected	5	1	3	14
Low energy sand beach	5	3	3.5	16.5
Cliff/platform or cliff/platform/beach	5	1	1	12

Vulnerability

Marine Birds

- Alcids are the most vulnerable of the marine birds to oil spills due to their feeding methods (swimming and diving from the surface), their tendency to roost on the water, and their tendency to congregate in large flocks (King and Sanger, 1979; Wahl *et al.*, 1981; Duval and Vonk, 1987; Vonk and Duval, 1990). Alcids have commonly suffered higher mortalities from oil spills than other birds (King and Sanger, 1979). For example, 81.4% of all dead, oiled birds recorded from the Nestucca spill on the west coast of Vancouver Island from January 3 to February 5, 1989 were alcids (Rodway *et al.*, 1989).

- Diving ducks and divers are very vulnerable to oiling due to their tendency to be on the water close to shore and their mode of feeding by diving from the surface. Diving ducks, loons, grebes and cormorants were found dead and oiled after the Nestucca spill (*ibid.*). Of particular concern are Pelagic and Brandt's cormorants which breed in the study region, and scoters which congregate in nearshore areas in midsummer to moult, during which time they are particularly vulnerable to oiling because of their flightless condition.

- Petrels spend the greater proportion of their time offshore, coming inshore only in summer to breed. They feed primarily from the air but also spend time roosting on the water in large flocks (King and Sanger, 1979). Hence, their vulnerability is moderate-high.

- Shorebirds generally spend little time on the water, making them less vulnerable to external oiling, but they are susceptible to ingesting oil from contaminated food. Shorebirds of rocky habitats are vulnerable due to the fact that most of their food is derived from the intertidal zone (Angell and Balcomb, 1982). Black Oystercatchers are particularly vulnerable because they often nest just above the high water mark (King and Sanger, 1979; Speich and Wahl, 1989). Shorebirds of sand-mud habitats tend to feed, roost and flock just above or below the tideline (Angell and Balcomb, 1982), and therefore may be less vulnerable than those that inhabit rocky habitats.

- Gulls are less vulnerable than diving birds due to their tendency to spend a greater amount of time in the air than on the water (Vonk and Duval, 1990). However, they are susceptible to oil ingestion and external oiling when feeding in contaminated intertidal areas. In addition, Glaucous-winged gulls nest close to the water's edge.

- Dabblers, geese and swans are the least vulnerable of the birds because they spend most of their time in backshore and terrestrial areas as opposed to on the water (Vonk and Duval, 1990).

Marine Mammals

- Harbour seals are very vulnerable to oil spills, especially during moulting and pupping seasons (late spring and summer) when they are hauled out in groups in intertidal areas.

- Sea lions are vulnerable due to their tendency to congregate on haulout sites.

- The grey whales that do occur in nearshore areas tend to feed on mysids in kelp beds and on the bottom of shallow bays which makes them somewhat vulnerable to oil spill impacts.

- Orca are considered to be of low vulnerability to oil spill exposure due to their nomadic lifestyle. In addition, other cetaceans have been observed to detect and avoid thick surface oil (Duval and Vonk, 1987), and it is assumed that orca are also capable of this behaviour.

Fish

- Salmon juveniles are vulnerable while staging in estuarine and nearshore areas before going to sea. Adult salmon also concentrate in these areas during spawning seasons but appear to be capable of avoiding high concentrations of hydrocarbons (Duval and Vonk, 1987; N.B. Hargreaves, pers. comm.).

- Herring are highly vulnerable during spawning seasons when adults and spawn are concentrated in nearshore habitats.

- Of the shellfish groups, intertidal species such as clams are highly vulnerable due to their location, sessile habit, and filter feeding habit. Subtidal benthic invertebrates (crab, urchins, geoduck and abalone) may be less susceptible due to the greater depths at which they occur. However, in the Nesticca spill, 100% of crabs trapped in the area were oiled, with a small percentage still lightly oiled 3 months after the spill (Duval *et al.*, 1989). Pelagic invertebrates (shrimp, squid) are considered least susceptible. Planktonic larval stages of many invertebrate species that occur in the upper levels of the water column may be highly susceptible to oiling, but could not be considered here due to the lack of distribution data.

Nearshore Biological Productivity

- All shore zone types were rated as highly vulnerable to oiling by virtue of their location and fixed state.

Sensitivity

Marine Birds

- Marine birds are generally considered to be highly sensitive to oil exposure relative to other marine organisms (Duval and Vonk, 1987; King and Sanger, 1979; Rodway *et al.*, 1989). Impacts are of two types: contamination of plumage with subsequent loss of insulation and buoyancy (external), and ingestion of oil through contaminated food or while attempting to clean plumage (internal). External impacts are the most immediate cause of mortality, but small amounts of ingested oil can detrimentally affect growth rates and reproductive success, and can ultimately cause death.

Marine mammals

- Harbour seals exhibit a variety of sublethal (S1) effects to oil contamination: e.g., fouling of flippers, clogging of respiratory openings, eye irritations (Duval and Vonk, 1987; Vonk and Duval, 1990). Mortality (S2) is fairly low; seals have been observed to recover once they move out of oil contaminated areas, and few direct mortalities have been observed (*ibid.*).

- Similar sublethal effects as those that affect seals are assumed for sea lions. Mortality is assumed to be lower than for seals due to the larger size of these animals and the absence of pups in the study region.

- Some sublethal effects have been observed or are assumed possible in grey whales: e.g., behavioral responses (decreased time spent at the surface, faster blow rates and altered swimming patterns in oiled areas) and potential physical fouling of baleen that would impair feeding (Duval and Vonk, 1987; J. Darling, pers. comm.). Some hydrocarbon accumulation in tissues (particularly blubber) has been detected in other cetaceans, although they may be able to detoxify and excrete these substances (Duval and Vonk, 1987).

- Orca feed primarily on fish or other marine mammals, and may be subject to some sublethal effects from ingestion of oil-fouled prey. Potential for mortality is low.

Fish

- Adult salmon are affected mostly by physical oiling by non-soluble hydrocarbon components. These effects include clogging of gills and adherence of oil to the scales. Effects on the physical appearance and potential tainting of the meat reduces the value of the fish as an economic or subsistence resource. Juvenile salmon are much more susceptible to toxic effects of soluble hydrocarbon components than adults (*ibid.*).

- Adult herring may not be greatly affected by the presence of oil but may avoid spawning in oiled areas (Duval *et al.*, 1989). Herring eggs, however, are easily smothered as a result of physical oiling by the non-soluble components. They may not be able to adhere to the surface of oiled rocks, kelp or eelgrass, resulting in greatly reduced spawning success. Consequently, herring sensitivity is rated as very high in areas where spawning occurs.

- Intertidal shellfish are very sensitive to oiling. Mortality commonly occurs by smothering and interference with feeding by stranded oil (Duval *et al.*, 1989). Complete elimination of intertidal

clam beds has been documented in heavily oiled areas (*ibid.*). Benthic and pelagic species are likely similarly sensitive to oiling. In addition, shellfish will retain oily flavours for a long time even if relatively small amounts of oil remain in the environment.

Nearshore Biological Productivity

- In general, relative sensitivity of shore zone types was assumed to increase with relative productivity. Estuaries were considered the most productive and therefore most sensitive, followed by protected intertidal flats and then the remaining shore zone types.

Recovery Period

Marine Birds

- Alcid and Trumpeter swans have long recovery periods because of their low fecundity (1-2 eggs/clutch) and late maturity (3-4 years) (King and Sanger, 1979). Rates of recovery of other bird species would be shorter in comparison, due to higher reproductive potentials or capacity for recruitment from other areas.

Marine Mammals

- Population recovery would likely be short for Harbour seals due to high immigration and the current high rates of population increase (Olesiuk *et al.*, 1988). The population recovery period is also considered to be rapid for both species of sea lions for similar reasons (Bigg, 1984, 1985).
- Should grey whales or orca suffer severe sublethal or lethal effects, recovery rates would be very long.

Fish

- Population recovery rates in salmon would vary according to when the spill struck relative to the seasonal and annual cycle of the particular populations. Migration behaviour of adults has been observed to be temporarily disrupted in spill areas (Duvall and Vonk, 1987). Population recovery potential is assumed to be moderate.

- Herring populations could be severely affected in specific, high spawning areas such that local recovery would take some time.

- Recolonization by intertidal shellfish would be determined by the rate at which substrates are cleaned by oil. Cleaning is greatest in areas of high wave energy, where rocky substrates would be washed of oil fairly rapidly. Species such as clams and oysters inhabit relatively low energy intertidal areas; hence, recolonization could take some time. Rates of recolonization of all types of shellfish would be reduced if an oil spill occurred during times of reproduction when larval stages are in the surface plankton or just settling in shallow areas.

Nearshore Biological Productivity

- Recovery time was assumed to be directly related to the oil residency ratings of the shore zone types (see section 2.3 of this Appendix). Estuaries and protected mixed sediment beaches have the longest oil residency times and therefore the longest recovery periods. By comparison, oil is more rapidly washed away or does not penetrate the other coastal types to a similar extent.

2.2.5 Abundance Values of Biological Elements

For elements for which the total population for the study region could be estimated and for which specific sites of concentration could be identified (breeding and moulting birds, Harbour seals, California and Steller sea lions, and salmon species), it was assumed that any ESA containing more than 50% of the study region's population represented a significant proportion of that population. Relative regional abundance (RA) values for these elements were assigned on the following basis:

RA Value	Criterion
1	>0-10% study region's population
2	11-20% " "
3	21-35% " "
4	36-50% " "
5	>50% " "

For the remaining elements for which a regional population size could not be derived and/or specific sites could not be identified (wintering and migrating birds, grey whales, orca, shellfish, biological productivity), alternate assumptions were made regarding relative regional abundance (Table A7). These assumptions are discussed below along with seasonal modifiers (SM) and importance modifiers (IM).

Table A7

Relative Abundance (A) Value Derivations for Biological Elements

(See section 2.2.2 for explanations of RA, SM and IM)

Note: $A = RA * SM * IM$

RA =	1	2	3	4	5	SM	IM
Bird colony or moulting group	% of Study Region's breeding/moulting birds for each species:						
	>0-10%	11-20%	21-30%	36-50%	>50%	0.25-0.60	1
Migratory/overwintering:	% of Study Region's average density (AD) in #birds/km:						
Diving ducks	<1	1-2	2-3.5	3.5-5	>5	0.75	1
Divers	"	"	"	"	"	0.75	1
Shorebirds	"	"	"	"	"	0.5	1
Gulls	"	"	"	"	"	1	1
Dabblers and geese	"	"	"	"	"	0.25	1
Swans	"	"	"	"	"	0.25	3
Harbour seals	% of Study Region's population:						
	1-10%	11-20%	21-35%	36-50%	>50%	1	1
Sea lions	% of Study Region's winter population:						
	1-10%	11-20%	21-35%	36-50%	>50%	0.25 per season	1
Grey whales	sighted on occasion	-	regular sightings	-	-	0.75	1

Orca	all ESA's	-	specific bays	-	-	1	1
Salmon	% of Study Region's population of any species:						
	1-10%	11-20%	21-35%	36-50%	>50%	1	1
Herring	Frequency of spawning - # years out of 50:						
	1-20	-	21-35	-	>35	0.25	1
Shellfish	-	-	some use	-	high conc.	1	1

Marine Birds

Breeding and moulting populations: Approximately 1,915 pairs of birds of 10 species breed in the study region (Table A8). Any ESA containing more than 50% of the breeding pairs of any species in the study region represented a significant proportion of that species' local population, and was rated as 5 (Table A7).

Table A8
Breeding Birds in the Study Region
(data from Rodway and Lemon, 1989)

Species	Number of Colonies in the Study Region	Percent of B.C.'s Breeding Population
Fork-tailed Storm Petrel	380	10.08
Least Storm Petrel	860	10.08
Pelagic Cormorant	500	65.6
Brandt's Cormorant	6	13.2
Black Oystercatcher	18	40.9
Glaucous-winged Gull	1370	62.4
Pigeon Guillemot	95	21.0
Cassin's Auklet	1 (320 birds)	0.01
Rhinoceros Auklet	260	10.04
Tufted Puffin	1 (16 birds)	0.02

SM's varied according to species. Alcids are known to aggregate around colonies before and after breeding (Campbell *et al.*, in press). These aggregations were assumed to occur from May to September 15, and consequently, alcid colonies were assigned SM's of 0.60. Black Oystercatchers are year-round residents and since data on non-breeding distributions were lacking, it was assumed that nesting sites represented regions of residency and were assigned a SM of 1. Petrels, cormorants and gulls were assumed to inhabit colony sites only during the summer breeding season, and were assigned SM's of 0.25. Non-breeding distributions of cormorants and gulls were given separate consideration (see below). Since the breeding populations in the study region represent only small proportions of the breeding populations of any of these species in B.C., all were assigned an IM of 1.

Two species of diving ducks (White-winged and Surf Scoters) congregate in traditional areas of the study region during the 3-4 week period that they are moulting. Being relatively site-specific, moulting areas were treated in the same way as colonies.

Nonbreeding populations: Distribution data on migrating or wintering species were derived from the Coastal Waterbird Inventory File (CWIF) of the B.C. Ministry of Environment. The CWIF is a compilation of records from aerial, boat and shoreline surveys carried out between 1967 and 1982 by provincial and federal wildlife management agencies.

Absolute populations of these species in the study region could not be estimated from the available data. Instead, estimates of relative density for each bird group in a given ESA were generated by taking the maximum number of birds reported in any survey from the CWIF that covered that ESA and dividing by the shoreline length of the ESA. Maximum numbers were assumed to be the best indicator of the potential of an area to support a given bird group and to compensate for limitations in the data. The RA of a given bird group was determined by comparing the density in an ESA to the average density throughout the study region such that an ESA containing less than the average density was rated as 1 and one containing 5 times the average density was rated as 5 (Table A7).

Specific limitations in the CWIF data must be noted. While the CWIF

contains survey data for the entire province, relatively few surveys are recorded for the southwest coast of Vancouver Island; less than 5 surveys over a 12-year period and the majority are for winter. Counts of alcids, notably Common Murres and Marbled Murrelets, are noticeably absent, probably due to the difficulty in sighting these birds from the air. No comprehensive surveys have been conducted of these species (J.-P. Savard, pers.comm.). Finally, the survey areas reported in the CWIF differed substantially from the ESAs defined in this study, which means that estimates of bird densities in a given ESA are very approximate.

All divers (grebes, loons and cormorants) and diving ducks were assigned SM values of 0.75 to represent their presence in fall, winter and spring. Shorebirds were assigned an SM of 0.5 reflecting their presence in spring and fall. Gulls are year-round residents and were assigned an SM of 1. Dabblers and swans are found in the study region primarily in winter and were assigned SM's of 0.25. Swans were assigned an IM of 3 to reflect their designated status as "vulnerable" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, 1987). All other groups were assigned values of 1 as none of the populations in the study region represent a large proportion of B.C.'s population.

Marine Mammals

Harbour seals: The total population for the study region was estimated at 817 seals. Abundance ranges were calculated on the basis that >50% of the study region's total population represented a significant proportion and was assigned an RA of 5; lesser proportions were assigned accordingly (Table 5). Harbour seals occupy the study region year-round, and were assigned an SM of 1. Since the study region's population does not comprise a significant proportion of B.C.'s total population of 75,000-88,000 seals (Olesniuk *et al.*, 1989), the IM value was set at 1.

Sea lions: There are 3 wintering and 1 year-round haulout sites in the study region (Table A9). To take into account differences in the populations of each species in each season, RA's were assigned separately for California and Steller sea lions for each season. An RA value of 5 represented >50% of the study region's winter population (Table A7). SM values of 0.25 were assigned for each seasonal population. Both species were assigned IM values of 1.

Grey whales: On the basis of records collected for over 10 years, it appears that migrating grey whales frequent some parts of the study area more than others (J. Darling, pers.comm.). Hence, RA's were assigned on the basis of relative frequency of occurrence rather than absolute numbers (Table A7). SM was set at 0.75 to reflect the presence of whales from March to December (*ibid.*). IM was set as 1 as only a small proportion of the total Pacific population use the coastal waters in the study region.

Table A9
Sea Lion Haulouts in the Study Region
(from Bigg, 1984,1985)

Site	Season	California	Number Recorded:		Total
			Steller		
Race Rocks	winter	799	22	821	
	spring	90	210	300	
	summer	-	7	7	
	fall	296	100	396	
Sombrio Pt.	winter	93	unknown	93+	
	spring	60	10	70	
	summer	-	1	1	
	fall	-	15	15	
Carmanah Pt.	winter	-	124	124	
	spring	-	75	75	
	summer	-	200	200	
	fall	-	35	35	
Pachena Pt.	winter	-	126	126	
	spring	-	105	105	
	summer	-	2	2	
	fall	-	130	135	
Study Region	fall, winter	892	400	1,292	

	summer	-	210	210
B.C.	fall, winter	3,000	8,000	10,500
	summer	-	7,000	7,000

Orca: The 3 pods of resident orca (83 animals) use the entire study region with no apparent site preference. Transient orca (approximately 75 animals) tend to linger in large bays and inlets; in particular, Sooke Harbour, Becher Bay, and Port San Juan. These areas are designated RA values of 3; all other ESAs, with the exception of very shallow inlets, were designated an RA of 1. Orca are present year-round and were assigned an SM of 1. IM was set at 1 since this population does not represent a large proportion of the total B.C. population.

Fish

Salmon: Distribution and abundance of the 5 Pacific salmon species and steelhead were estimated on the basis of escapement records over the last 30-45 years for the spawning streams that occur in the study region (Brown *et al.*, 1979; Fisheries and Oceans Canada, 1987 and 1990). Maximum escapements were used as the best indicator of potential importance of an area to salmon. These data were supplemented by unpublished data for streams for which escapements have not been systematically recorded but which have been observed to support small stocks (McInnis and Pollard, 1977; P. Bruce, pers.comm.; D. Lindsay, pers.comm.). Distributions and sizes of sea-run Cut-throat trout populations were estimated by B.C. Ministry of Environment staff (P. Law, pers.comm.).

RA's were calculated for each salmonid species in each ESA containing one or more salmonid-bearing streams on the basis of the percentage of total maximum escapement for that species in the study region. Greater than 50% of the total maximum escapement for the study region was considered significant and was assigned an RA value of 5; lesser proportions were assigned lower RA values accordingly (Table A7). Each ESA was assigned the highest RA value derived for any salmon species in that ESA. This means that an ESA having greater than 50% of the total maximum escapement of any salmonid species was assigned

an RA of 5.

SM was set at 1 for all salmonid species to reflect the presence of resident or migrating adults or juveniles of one or more species over the course of a year. IM was set at 1 as the study region's populations comprise only small proportions of province-wide populations for all species.

Herring: Herring spawn records have been maintained for 50 years for most of the B.C. coast (Hay, *et al.*, 1989). ESAs were ranked according to the number of years out of that 50-year period that spawning has occurred in that ESA (Table A7). Spawning occurs only in spring and therefore, this element was assigned an SM of 0.25. Very little spawning occurs in the study region relative to the remainder of B.C. such that an IM value of 1 was assigned.

Shellfish: As a consequence of the qualitative nature of the distribution data, any ESA containing a site harbouring shellfish populations of commercial or subsistence value was assigned an RA-value of 3 for that shellfish element. SM was set at 1 to indicate year-round residency of shellfish populations. IM was set at 1 as it is presumed that none of the populations in the study region are rare, endangered or represent a significant proportion of B.C.'s population.

Nearshore Biological Productivity

The regional abundance of any shore zone type and its associated biological productivity was derived by normalizing the lengths (km) of all shore zone types to a scale of 0 to 5. The maximum ESA length (9.6 km) was assigned an RA of 5 and the RA of each shore zone type was calculated by:

$$RA = \text{length (km) of shore zone type} \times 5/9.6.$$

SM and IM were assumed to be 1 such that relative abundance (A) = RA.

The Assigned Value for biological productivity (AV_{bp}) of a given segment of shoreline in an ESA was the product of its Relative Sensitivity (RS) and the Relative Abundance (A) values in that ESA. As the majority of ESAs were comprised of segments of different shore zone types with different RS and A values, the AV_{bp} for an ESA was derived by summing the AVs for

each segment in that ESA:

$$AV_{bp} = \sum_{\text{Seg:1}}^{Seg:n} RS \times A$$

2.2.7 Conclusions - Biological Category

The overall Biological Sensitivity Value for an ESA was calculated by summing all of the Assigned Values (products of Relative Sensitivity and Relative Abundance) for the elements that occurred in that ESA:

$$AV_{\text{Element}} = RS \times A$$

$$\text{Biological Sensitivity Value for ESA} = \sum_{\text{Element 1}}^{\text{Element n}} AV$$

The Sooke River estuary and Basin region, Race Rocks, the Gordon-San Juan River estuary system, and Nitinat Narrows top the list in terms of biological sensitivity to oil spills. Estuaries tend to rank among the most sensitive areas, due to their high biological productivity, importance to salmon runs, and their attractiveness to bird populations. Reefs and headlands, such as Race Rocks, Cape Beale and Pechena Point, that support bird colonies and marine mammal concentrations also emerge among the most sensitive areas.

The contributions of the biological elements by major group (birds, marine mammals, fish and shellfish, and biological productivity) to the total Biological Sensitivity Value for each ESA are indicated in Table A10. This indicates that while marine birds were represented by the greatest number of individual biological elements (see Table A6), they did not disproportionately dominate the total values. For example, while birds made up the greater percentage of sensitivity values for Race Rocks (ESA #1) and Seabird Rocks (ESA #57) where they are dominant factors, they accounted for less than 50% of the total value for other very sensitive areas: e.g., Sooke River estuary (ESA #12) and Gordon/San Juan River estuaries, where fish were dominant factors.

It must be emphasized that this table is intended only as a broad indicator of relative biological sensitivity. The method used to generate it, while rational and repeatable, relies on a variety of assumptions regarding biological significance, vulnerability and sensitivity. Its application suffers from limited population and distribution data for many elements. Therefore, the specific value or exact order of coastal areas in terms of biological importance should not be considered literally. Rather the listing should be used only as a general guide. Moreover, attention should be paid to specific elements that comprise the relative ratings according to the time of year, weather conditions and other characteristics of a spill. For example, Seabird Rocks (ESA #57) harbours the largest and most diverse marine bird colony in the study region as well as one of the larger Harbour seal haulouts. Despite the fact that it does not head the list in terms of its Biological Sensitivity Value (likely due to the lack of significant distributions of other biological elements), this strategic site should be given high priority for any spill that occurs in spring or summer. Similarly, Botanical Beach (ESA #31) rates relatively low; little data exists regarding bird, fish and mammal populations here, yet it is well known for its unique tidepools and diversity of intertidal flora and fauna.

Hence, while the listing provides a "first-cut" index of priority areas in terms of biological sensitivity to oil spills, users must also pay attention to other areas according to the component elements and local knowledge that may be critical in assessing any particular spill situation.

Table A10
Biological Sensitivity Values for ESAs by Biological Group

ESA no.	Birds	Marine Mammals	Fish & Shellfish	Biological productivity	Total Rating	Scaled Rating (1-10)
1	323.50	153.34	69.00	0.00	545.84	9.5
2	130.75	26.50	123.00	11.00	291.25	5.1
3	128.25	37.00	123.00	11.85	300.10	5.2

Table A10
(continued)

ESA no.	Birds	Marine Mammals	Fish & Shellfish	Biological productivity	Total Rating	Scaled Rating (1-10)
4	107.00	21.00	123.00	13.04	264.04	4.6
5	32.00	19.50	123.00	0.00	174.50	3.
6	32.00	10.50	69.00	2.01	113.51	2.0
7	86.00	0.00	162.00	54.54	302.54	5.3
8	86.00	0.00	156.00	11.36	253.36	4.4
9	86.00	0.00	210.00	46.53	342.53	6.0
10	86.00	0.00	204.75	0.00	290.75	5.1
11	86.00	0.00	135.75	54.72	276.47	4.8
12	257.50	0.00	233.25	83.28	574.03	10.0
13	86.00	21.00	135.75	56.95	299.70	5.2
14	47.00	37.00	176.25	49.60	309.85	5.4
15	51.25	10.50	162.00	18.41	242.16	4.2
16	47.00	26.50	83.25	34.36	191.11	3.3
17	47.00	19.50	14.25	37.72	118.47	2.1
18	77.00	10.50	0.00	7.13	94.63	1.6
19	77.00	19.50	0.00	2.78	99.28	1.7
20	97.00	10.50	123.00	15.76	246.26	4.3
21	64.00	10.50	123.00	21.38	218.88	3.8
22	47.00	19.50	194.25	30.85	291.60	5.1
23	52.00	26.50	0.00	8.53	87.03	1.5
24	47.00	10.50	0.00	20.59	78.09	1.4
25	47.00	10.50	0.00	23.87	81.37	1.4
26	47.00	10.50	0.00	16.85	74.35	1.3
27	47.00	70.42	54.00	14.32	185.74	3.2
28	32.00	10.50	54.00	17.68	114.18	2.0
29	32.00	10.50	0.00	29.45	71.95	1.3
30	37.00	10.50	54.00	24.23	125.73	2.2
31	32.00	10.50	184.75	28.03	255.28	4.4
32	52.00	39.00	138.75	0.00	229.75	4.0
33	52.00	39.00	121.50	2.37	214.87	3.7
34	101.50	39.00	194.25	71.66	406.41	7.1
35	47.00	39.00	121.50	0.00	207.50	3.6

Table A10
(continued)

ESA no.	Birds	Marine Mammals	Fish & Shellfish	Biological productivity	Total Rating	Scaled Rating
36	47.00	39.00	151.50	14.58	252.08	4.4
37	17.00	35.50	0.00	44.82	97.32	1.7
38	123.25	19.50	0.00	38.60	181.35	3.2
39	17.00	19.50	0.00	30.93	67.43	1.2
40	15.00	19.50	57.00	26.07	117.57	2.0
41	39.50	19.50	69.00	20.11	148.11	2.6
42	39.50	19.50	83.25	0.00	142.25	2.5
43	39.50	99.30	69.00	13.19	220.99	3.8
44	66.00	28.50	69.00	0.00	163.50	2.8
45	66.00	44.50	69.00	23.52	203.02	3.5
46	129.75	28.50	97.50	26.01	281.76	4.9
47	76.00	28.50	69.00	15.59	189.09	3.3
48	108.00	28.50	194.25	29.16	359.91	6.3
49	87.50	44.50	54.00	0.00	186.00	3.2
50	87.50	28.50	123.00	16.44	255.44	4.4
51	87.50	28.50	97.50	24.66	238.16	4.1
52	87.50	28.50	69.00	18.08	203.08	3.5
53	87.50	28.50	69.00	13.56	198.56	3.5
54	87.50	83.30	69.00	35.12	220.12	3.8
55	87.50	83.30	69.00	17.94	257.74	4.5
56	87.50	28.50	0.00	24.64	140.64	2.5
57	179.00	60.50	0.00	0.00	239.50	4.2
58	86.00	39.00	162.00	15.69	302.69	5.3
59	86.00	0.00	151.50	35.13	272.63	4.7
60	81.00	21.00	54.00	16.85	172.85	3.0
61	81.00	28.50	69.00	16.04	194.54	3.4
62	140.75	10.50	0.00	1.59	152.84	2.7
63	170.75	44.50	69.00	17.81	302.06	5.3
Total	5014.75	1711.86	5650.75	1356.98	13734.34	

2.3 Shoreline Oil Residence Category

2.3.1 Introduction

This section provides an overview of the coastline of southwestern Vancouver Island and a description of the methodology used to estimate the potential oil residence in the shore zone. In practice, the persistence of oil in the shore zone is controlled by many factors such as oil type and volume, wave exposure and coastal morphology. Some of these factors can be evaluated prior to a spill to evaluate potential sensitivities of different coastal segments. Wave exposure, substrate type, coastal morphology and coastal processes are some of the factors that can be evaluated prior to a spill; these factors are utilized to estimate potential oil residence in this project. The general distribution of the coast and coastal processes is presented as background to the development of potential oil residence estimates.

2.3.2 Description of the Coast and Processes

This section provides a summary of the coastal character of the southwestern coast of Vancouver Island, a brief review of the coastal processes and an assessment of the potential oil residence of shoreline types on the southwest coast of Vancouver Island. No new field data were collected, and the descriptions herein rely on previously published information.

Regional Description

Detailed coastal maps at a map scale of 1:16,000 and a linked database provide a high degree of detail on the wave exposure, substrate, stability and morphology of the study area (e.g., Harper, 1981; Harper and Sawyer, 1983; Owens, 1981). Other field studies of seasonal beach elevation change provide some index of the coastal processes active along this section of coast (Harper, 1980).

Basically the coast is one of high wave exposure and rock or coarse sediment beaches. The northern portion of the study area is affected by Pacific swell with a mean annual significant wave height in excess of 2 m. Swells propagate into the Strait of Juan de Fuca and, except in protected

bays and estuaries, provide high background wave exposure levels within most of the study area. Wave exposure is highest at Cape Beale and decreases to the southeast. Pacific swell is commonly observed at Whiffin Spit in Sooke and degraded Pacific swell has been recorded in Victoria (see Appendix B for details on marine climate).

Tidal range, important in distributing the wave energy within the intertidal zone, varies from 2.8 m during mean tides to 4.1 m during large tides (see Appendix B).

The coast is dominated by rock cliffs and coarse sediment beaches. Rock cliffs, commonly with intertidal wave-cut platforms are found along approximately 60% of the coast and coarse sediment beaches occur along approximately 40% of the coast, sometimes in combination with rock platforms or cliffs. Sand beaches occur along approximately 10% of the coast. Cliff morphology is strongly controlled by bedrock type: cliffs with wide intertidal platforms are restricted to sedimentary bedrock areas whereas ramped and narrow-cliffed shores without platforms are most commonly associated with igneous and metamorphic bedrock areas (Harper, 1980).

Coastal processes are strongly affected by the high wave exposure levels. It appears that most sand-sized sediment and smaller sediment is moved offshore by mechanical wave energy leaving coarse sediment veneers over bedrock or pre-Holocene glacio-marine sediments; most beaches are typically a pebble, cobble or boulder lag of less than 0.5 m in thickness, over more poorly sorted glacial/marine sediments or bedrock. Beaches usually occur in association with nearby river sources, i.e., beaches are essentially elongated river or stream deltas. Longshore transport is predominantly from west to east as a result of the dominant wave approach from the northwest into the Strait, although numerous headlands limit sediment transport into smaller sediment transport cells.

Seasonal variations in wave energy levels also affect the coastal processes. Mean significant wave heights along the western, exposed coast are around 3 m in December whereas during July they are approximately 1 m. This may cause an associated seasonal variation of beach changes with beaches undergoing erosion during the high wave energy winter months and accretion during lower wave energy summer months, particularly on the

western-most beaches (Harper, 1980). On more eastern beaches, locally generated waves may complicate this pattern of change with the cycles dominated by periodic storms and intervening quiescent periods.

Coastal Types (Substrate and Morphology)

Shoreline types mapped by Harper (1981) and Owens (1981) were used as a guide for mapping shoreline and establishing oil residence indices in this study. The following modifications to this mapping scheme were made for use in the present study:

- The cliff with veneered platform type occurs infrequently (<1%) in the study area, and this type was combined with cliff with platform.
- Coastal segments of alternating rock headlands and pocket beaches that were too small to be mapped at the 1:40,000 mapping scale of this study were redefined as a headland/pocket beach type.
- An additional coastal type of estuaries/lagoons was also defined for this study. This coastal type was included to reflect the very sheltered, tidally influenced areas of many of the small river mouths that occur within the study area. Examples of this coastal type are the following: the river mouth areas of the Pachena, Cheewat, San Juan, Jordan and Sooke Rivers. The low wave exposure and presence of marshes make this coastal type particularly sensitive to oil spill impact.

The nine coastal types mapped as part of this study are listed in Table A11, and a description of each of the shoreline types is provided. These shoreline types are the same as those illustrated in the operational maps (Section 3.0 of the atlas).

Table A12 provides a summary of the distribution of the coastal types within the study area. Approximately 55% of the coast is backed by rock cliffs and beaches occur along 40% of the coast. Intertidal flats comprise less than 10% of the coast as do estuaries. Anthropogenic shorelines

comprise less than 1% of the coast.

Table A11
Southwestern Vancouver Island Coastal Types
(after Harper, 1981; Owens, 1981)

Cliff - rock substrate with narrow (<30m) to vertical intertidal zone; common in areas of igneous or metamorphic bedrock and high wave exposure.

Cliff with Platform - rock substrate with wide (>50m) intertidal platform backed by a steep gradient ramp or cliff; generally associated with areas of sedimentary bedrock and high wave exposure; occasionally platform has thin veneer of coarse sediment (i.e., the platform with veneer of Harper, 1981).

Cliff with Platform and Beach - rock substrate with wide (>50m) intertidal platform with a beach veneer in the upper part of the intertidal zone; generally associated with sedimentary bedrock and high wave exposure; beach material commonly coarse (pebble, cobble, boulder) and associated with fluvial sediment sources.

Headland/Pocket Beach - alternating rock headlands, most commonly narrow (<20m) cliffs, and small pocket beaches, most commonly mixed-sediment beaches (<30m). This coastal type was not defined in the original classification but was required by the lower resolution map scale used in this project.

Mixed Sediment Beach - steep, poorly sorted beach comprised of sand, granule, pebble, cobble and boulder fractions; along the Strait of Juan de Fuca, sediments commonly grade from finer material at the low water line to coarse at the high water line. Widths generally less than 30m.

Sand Sediment Beach - predominantly sand-sized material; material is very mobile and subject to extensive reworking during storm events and on a seasonal basis (Harper, 1980). Widths to 100m.

Intertidal Flats - wide (>50m) intertidal flat comprised of sand and/or mud; most commonly associated with low wave exposure.

Anthropogenic - shore zones that have been modified by man; substrate may be rubble, concrete, wood or metal.

Estuaries - small lagoons or estuaries most commonly associated with river and stream mouths. Frequently include sand beaches, intertidal flats and marshes.

Figures A1 to A6 show examples of different coastal types in the study area.

Table A12
Summary of Coastal Types on Southwestern Vancouver Island

Shoreline Type	Length (km)	Percentage
Cliff	67.1	23.4
Cliff with Platform	44.0	15.3
Cliff with Platform & Beach	43.4	15.2
Headland/Pocket Beach	16.3	5.7
Mixed Sediment Beach	51.8	18.1
Sand Beach	24.9	8.7
Intertidal Flats	19.4	6.8
Anthropogenic	1.2	0.4
Estuaries	18.4	6.4
Total Length	286.6 km	

Wave Energy

Only approximate values of wave exposure are available for the study area coastline as no detailed measurements have been made. Owens (1981) provides a very general scheme for estimating relative wave exposure levels. In this scheme, wave energy within a specific coastal segment is estimated from (a) wave fetch distances and (b) the degree of crenula-



Figure A1 Oblique aerial photograph of Muir Creek estuary. The photo also shows a log booming area and a "low-wave exposure" anthropogenic shore, which is a permeable, rubble-material groin.



Figure A2

The photograph shows a moderate exposure, mixed-sediment pocket beach near the mouth of the San Juan River. Sediments include the following: boulder, cobble, pebble, granule and sand. Slightly lower wave exposure at this location results in more sand-fraction in the substrate and as such, lower permeability.

Photographs: J. Harper



Figure A3 A sand beach, with some cobbles, near the mouth of Walbran Creek. The substrate is highly mobile.



Figure A4 A ground photo of a rock platform with a boulder veneer in the middle and lower intertidal zones, and a pebble/granule/sand berm in the upper part of the intertidal zone.



Figure A5 An oblique aerial photo of a wave-cut rock platform near Owen Point. The only mobile sediment occurs in a small pocket beach visible in the centre of the photo.

Figure A6 An oblique aerial photograph near-vertical rock cliffs (to the right) at the mouth of Nitinat Narrows.



Wave Energy

Only approximate values of wave exposure are available for the study area coastline as no detailed measurements have been made. Owens (1981) provides a very general scheme for estimating relative wave exposure levels. In this scheme, wave energy within a specific coastal segment is estimated from (a) wave fetch distances and (b) the degree of crenulation of the segment. Straight coastlines with large fetch distances have high wave exposure levels whereas crenulated coasts with the same fetch distance have lower wave exposure levels.

For purposes of this study the following more general classification of wave exposure is used.

HIGH Wave Exposure	fetch > 20km, straight and crenulated coasts.
MODERATE Wave Exposure	fetch 5 to 20km, straight, crenulated and sheltered coasts.
LOW Wave Exposure	fetch < 5km, straight, crenulated and sheltered coasts.

The distribution of wave categories within the study area is categorized in Table A13 and is based on the data in Owens (1981). Two wave exposure classes predominate with high wave exposure comprising 80% of the coast and low wave exposure the remaining 20%. This disparity reflects the important difference between the open, exposed coast and the protected estuaries and embayments; the lack of moderate exposure coasts indicates the rapid transition from high to low wave exposure on this coast.

Table A13
Relative Distribution of Wave Exposure Categories
(based on data from Owens, 1981)

Region	Wave Exposure Category (km)		
	HIGH	MODERATE	LOW
Race Rocks to Sooke Harbour	38.5	-	46.7
Whiffin Spit to Otter Pt	10.1	20.9	0.7
Otter Pt to Jordan River	20.9	19.7	1.7
Jordan River to Sombrio Pt	19.7	20.7	0.4
Sombrio Pt to Port San Juan	20.7	17.3	0.2
Port Renfrew	17.3	41.2	2.3
Owen Point to Nitinat Narrows	41.2	38.3	2.0
Nitinat Narrows to Pachena Bay	38.3	7.9	-
Pachena Bay	7.9	16.9	2.7
Cape Beale	16.9	-	0.1

TOTAL	229.8	0	56.8
Percent	80%	0%	20%

Coastal Processes

Dominant longshore sediment transport directions are indicated on the maps. Although there is a general transport trend from west to east, this is not strongly developed in most areas.

Measurements of beach elevation changes over a one year period indicate a complex pattern of change that appears to be related to major storm events within the Strait of Juan de Fuca. Lowest beach elevations occurred in November/December and highest beach elevations occurred during the spring to summer months (Harper, 1980). Although typical beach elevation changes were about 0.5m over the year, sweep zone thickness (the difference between the highest and lowest elevations) increased in a northwesterly direction to 1.3 m at Port Renfrew. This suggests that beaches in the northwestern portion of the study area are

significantly more dynamic than those to the southeast.

The pattern of change was not as consistent as the winter/summer cycle noted on Long Beach possibly due to the bipolar wind pattern that occurs within the Strait (Harper, 1980). This pattern likely generates local waves which may introduce a pattern of longshore sediment cycling on the smaller pocket beaches that occur along the Strait.

2.3.3 Factors Affecting Oil Residence

Oil residence was selected as the indicator of potential oil impact to the shoreline. Estimates of potential oil residence provide an indication of the length of time that oil may remain on the shoreline. This estimate is thought to be most useful for assessing impacts to the biological communities and to cultural uses of the shore zone with the implicit assumption that the longer oil is present, the greater impact that it will have to intertidal communities and to cultural use. Note that the oil residence index does not necessarily reflect the volume of oil that may remain in the shore zone nor the toxicity of oil that may remain in the shore zone.

Many factors affect the potential residence of oil in the shore zone. Some of these can be determined before the spill occurs and others cannot be determined until the time of the spill, making pre-spill sensitivity analyses very approximate. Factors that affect oil residence and that can be estimated prior to a spill include the following:

- wave exposure
- substrate type, particularly permeability
- coastal processes
- coastal morphology (i.e., shore zone gradient)

Wave exposure is the most important factor affecting oil residence as it plays a primary role in the mechanical dispersal of stranded oil; wave action causes sediment movement which aids in the dispersal of oil from interstitial pore spaces and in the mechanical abrasion of oil that coats sediment particles.

Substrate is important in that it affects the permeability of the sediments and therefore the potential penetration of the oil. Impermeable substrates allow oil to be concentrated near the surface, allowing maximum effectiveness of waves in dispersing the oil. If the oil penetrates into the sediments, the effectiveness of the wave in dispersing the oil is reduced, resulting in a longer potential residence period. Similarly, coastal processes may cause oil to be buried, reducing effectiveness of the wave dispersion and resulting in longer residence periods. If, however, a shoreline is undergoing erosion, oil is more likely to be exposed to wave re-working, and therefore, have a shorter residence period.

These factors are not entirely independent in that areas of low wave exposure frequently have significant components of fine sediments and therefore lower permeabilities. High wave exposure areas are typically much more dynamic than low energy areas and, as such, experience large seasonal changes in sediment distributions. Table A14 indicates the relative effect of the above-listed factors.

Table A14
Factors Affecting Potential Oil Residence
(estimated prior to a spill)

In order of decreasing oil residence in each category

Wave Exposure

- fetch < 1km
- 1km < fetch < 10km
- 10km < fetch < 100km
- 100km < fetch or swell dominated

Shoreline Substrate

- organics/marsh
- permeable sediments (granule, pebble, cobble, boulder)
- less permeable sediments (mud, sand)
- "porous" bedrock
- smooth bedrock (few surface joints or fractures)

Shoreline Stability

accretional mudflat or beach (long term)
seasonal beach accretion
erosional tidal flat or beach

Shoreline Morphology

tidal flats
beaches
cliffs with platforms
cliffs

Additional factors that can not be determined until the time of the spill and that are very important in determining the length of oil residence are listed below.

- meteorological conditions at the time of the spill
- oil type
- degree of oil weathering (e.g., emulsification, evaporation, etc.)
- volume of oil

These factors will strongly influence the degree of saturation and penetration of oil into the sediments. In terms of pre-spill planning, these important factors are unknown, and pre-spill estimates of potential oil residence are only an approximation. Table A15 lists how each of the above-listed factors affects oil residence estimates.

Table A15
Factors Affecting Potential Oil Residence
(cannot be estimated prior to a spill)

In order of decreasing oil residence in each category

Oil Type

bunker oils
crude oils
light, refined oils

Degree of Weathering

unweathered
weathered

Volume of Oil

large
small

2.3.4 Classification of Oil Residence

The estimates of oil residence are based upon (a) previously mapped coastal types (e.g., Harper, 1981; Harper and Sawyer, 1983; Owens, 1981); (b) reviews of previous spills including Owens (1971, 1978), Owens and Rashid (1978), Hayes and Gundlach (1975), Hayes et al. (1979), Gundlach and Hayes (1977) and Gundlach et al. (1978); and (c) the personal experience of the author on fate and persistence studies of the Baffin Island Oil Spill (BLOS) and the *Exxon Valdez* spill.

Factors listed in Table A14 were used to first rank relative oil residence category based on shoreline type and wave exposure category. It was not possible to combine these factors into a quantitative matrix; however, the interdependence of some of the factors mentioned in Section 2.3.1 allowed a limited number of oil residence categories to be defined. The shoreline types (Table A11) and wave exposure (Table A13) were used as the

principle guide in development of the final oil residence ranking shown in Table A16.

Table A16
Summary of Guidelines Used to Assign Oil Residence Categories

Type/Exposure	Rationale for Ranking Value	ORI
Estuaries, low wave exposure	very low wave exposure, marshes and organic sediments result in very slow mechanical dispersion	10
Low wave exposure, mixed sediment beaches	low wave exposure and high permeability allow extensive penetration	10
Low wave exposure, permeable anthropogenic shores	low wave exposure and high permeability allow extensive penetration	10
Low wave exposure, sand beaches	low wave exposure and moderate permeability may allow moderate penetration	7
Moderate to high wave-exposure, mixed-sediment beaches	moderate wave exposure and high permeability may allow moderate penetration	6
Moderate to high wave-exposure headland/pocket beaches	high permeability of pocket beach sediments may allow moderate penetration	5
Moderate to high wave exposure sand beaches	seasonal beach changes or stranding of oil in backshore possible	4
Intertidal sand or mud flats	low permeability and high water tables limit penetration	4
Low wave exposure, rock cliffs	low permeability so no penetration, but low wave exposure leads to moderate residence	3

Cliff with platform with beach	some possible penetration of oil into berm but type generally associated with high exposure	2
Cliff with platform, Cliffs	impermeable substrate and generally high wave exposure limit residence	1
Impermeable anthropogenic structures	impermeable materials, such as sheet piling, limit residence.	1

After development of the ranking, an oil residence index (ORI) value from 1 to 10 was assigned to show the relative difference in potential oil residence. Actual oil residence will vary depending on specific spill circumstances but as a general guide, the following can be used for planning purposes:

ORI	Potential Residence Period
1-2	days to weeks
2-7	weeks to months
8-10	months to years

Unfortunately the Oil Residence Index is not very precise. Observations from the *Exxon Valdez* spill support the concept of a high degree of variability, both in time and space, of oil residence. The degree of oiling often varied several orders of magnitude over very short distances. Natural cleaning also varied significantly in that portions of one beach might be visually cleaned within a few months of the spill and other portions of the same beach showed little weathering.

As such, the ORI results are a useful planning tool both as an impact assessment guide and as a response preparation guide. The index allows the type and location of the most sensitive resources to be identified and also allows the type of countermeasure equipment to protect or clean up resources to be evaluated. The ORI is, however, of limited use at the time of the spill when additional information on the spill character and environmental conditions are known to make much more precise

predictions of potential oil residence possible.

2.4 Special Status Areas Category

Special Status Areas considered in this atlas include the following elements:

- heritage sites
- national parks
- provincial parks
- regional parks
- community parks
- forestry parks
- Indian Reserves.

Table A17 lists the Assigned Values for each element. Heritage sites are discussed in detail as one of the key elements of this category.

Table A17
Special Status Areas Category

Element	Assigned Value
Heritage Sites	0-10
National Parks	10
Provincial Parks	6
Regional Parks	6
Community Parks	2
Forestry Parks	2
Indian Reserves	6

2.4.1 Heritage Resources

Introduction

The primary document source consulted for compilation of heritage resource data within the study area and for the determination of site-specific heritage rankings was the B. C. Archaeological Site Inventory administered by the Archaeology and Outdoor Recreation Branch, Ministry of Municipal Affairs, Recreation and Culture. The provincial registry contained 164 heritage sites within the study area. The section of shoreline between Port San Juan and Cape Beale, encompassed by the West Coast Trail unit of Pacific Rim National Park, has been intensively surveyed (Haggarty and Inglis, 1985). In contrast, the shoreline section between Christopher Point and Port San Juan has not been surveyed systematically and, as a result, heritage site records for this section of the study area are often incomplete. In order to bring the heritage site record data base for this section of shoreline up to the current standard for sites in the Port San Juan to Cape Beale section, an intensive archaeological survey will be required.

All specific site records and maps (where they exist) were consulted for sites included in the atlas. The information necessary for calculation of site-specific sensitivity rankings were derived from these records and maps, and from extensive research experience in the area.

To ensure the protection of heritage sites included in this atlas, specific site information is provided in a confidential file held by the Ministry of Environment. This file would be referenced only in the case of an oil spill emergency involving sections of shoreline encompassed by this atlas. The exact location of specific heritage sites is intentionally obscured on shoreline unit maps through the use of large symbols. All heritage sites in B.C. are protected by the Heritage Conservation Act of B. C.

Site Sensitivity Ranking

Three different symbols have been used to identify heritage sites in the atlas. Each symbol represents a distinct level of sensitivity to an oil spill. The 164 heritage resource sites in the atlas have been ranked according to the following three factors:

vulnerability to oil,

sensitivity to shoreline treatment, and

relative importance of the heritage resource.

Vulnerability

The vulnerability of a heritage site is a measure of the potential for direct impact from oil. This factor is determined primarily on the basis of the location of a site within the shoreline segment. Sites located in the subtidal, intertidal or storm-tossed zones are considered directly vulnerable to oil impact while sites located in the near and far upland zones are not considered directly threatened by oil. Site vulnerability values are 0, for sites not directly vulnerable to oil, and 1, for those sites that are considered directly vulnerable to oil resulting from an offshore oil spill.

Sensitivity

The sensitivity of a heritage site is a measure of the potential impact to a site resulting from cleanup operations. Site location within a shoreline unit is also important in the calculation of the sensitivity of a specific site. Heritage sites are ranked on a scale of 3 to 1. Sites located in the intertidal and storm-tossed zones are given a numerical value of "3", indicating that the site is extremely sensitive to shoreline treatment. Heritage sites located in either the subtidal or near upland (within 30 m of the vegetation edge) zones are given a numerical value of "2", while those sites located in the far upland zone (greater than 30 m but less than 3 km from the vegetation edge) are given a numerical value of "1".

In an oil spill emergency, most heritage resource sites are threatened more by the decision to treat sections of shoreline than by direct impacts from oil. As a result, the site sensitivity value in the heritage site sensitivity formula is multiplied by a factor of "2".

Relative Importance

All sites included in the atlas are ranked according to their relative

importance or significance to regional historical reconstruction.

Assigning values indicative of the relative importance of a particular site is difficult due to the generalized nature of the task. It is not possible to take into account the different assumptions held, or measures used, by different investigators to determine site significance. This issue is further complicated by the fact that an intensive archaeological survey has been conducted only within the boundaries of Pacific Rim National Park. Site records from this portion of the study area are complete and far more detailed than site records from the remainder of the study area. As a result of the variability in the database, the relative importance of each site in the study area was determined primarily on the basis of recorded or estimated site size and inferred function (based on work in other areas of the west coast of Vancouver Island). Based on available site information, each heritage resource site in the study area was ranked on a scale of 3 to 1:

Rank 3

All potential village sites, shell middens with a surface expression in excess of 2,000 square metres, and all burial sites, including unmarked Native burial places as well as cemeteries, were given a numerical rank of "3". Burial sites were ranked high due to the extremely sensitive nature of this type of site.

Rank 2

Heritage sites given a numerical rank of "2" include all shell midden sites with a surface expression between 500 and 2,000 square metres, petroglyph sites with 5 or more images, large stone wall fish traps and large historic sites, including community remains, cannery remains, etc.

Rank 1

This numerical rank was given to all shell midden sites with a surface expression of less than 500 square metres, petroglyph sites with less than 5 images, small fish trap sites and small historic sites, including linesmen cabins, anchors, shipwrecks, etc.

more than one Indian Reserve occurs in one area the Assigned Value is modified from 6 to 7.

Heritage Resource Sensitivity Formula

The formula used in this atlas to calculate the heritage resource sensitivity (HRS) at the site level is:

$$HRS = V + (S \times 2) + I$$

where V = vulnerability
 S = sensitivity
 I = relative importance

This formula yields a range of numerical values from a minimum of 3 to a maximum of 10. The calculated value accurately reflects the overall sensitivity of a wide range of heritage resource sites to the potential impacts associated with an oil spill emergency off the southwest coast of Vancouver Island.

2.4.2 Parks

Parks are designated public sites. Their relative ranking can be based on the pattern and intensity of use and their market significance (Seakem Group, 1990). The parks are most heavily used during the summer months, from May to October; however, statistics are not available to accurately compare the relative intensity of use of the different parks. The Assigned Values are thus largely based on the perceived market significance of the parks. National Parks are given an Assigned Value of 10 as their market significance is international and national, as well as provincial and local. Community parks and forestry parks are given the lowest Assigned Value of 2 as their market significance is mainly local.

2.4.3 Indian Reserves

Indian Reserves are designated private sites and are given an Assigned Value of 6. Reserves that are inhabited receive an additional ranking as a community under the human use category.

Where more than one of each element occurred within one area the Assigned Value is modified by increasing it by one. For example, where

3.0 APPLICATION OF THE SENSITIVITY RANKING SYSTEM

The following section describes the application of the sensitivity ranking system to shoreline areas and the degree of environmental sensitivity based on the relative rankings. Actual sensitivity values for all areas are provided in Tables A18 and A19.

3.1 Definition of Areas for Sensitivity Ranking

The southwest coast of Vancouver Island (from Race Rocks to Cape Beale) was divided into 63 shoreline areas (also referred to as environmental sensitivity areas - ESA's) to facilitate the evaluation of spatial differences in the sensitivity of coastal resources to marine oil spills. The areas range in length from 0.5 to 9.6 km based on the distribution of shoreline types mapped by Harper (1981). For purposes of resource mapping, the area boundaries extend from approximately 2 km offshore (in order to accommodate inshore fisheries) to less than 1 km inland (further in the case of special status areas such as parks).

The criteria for mapping was more concerned with the potential for a resource to be impacted than any absolute distance. In most cases, vulnerable resources along the shore are limited to those which fall inside the extreme high tide line (exceptions are heritage sites in the immediate backshore which could be affected by cleanup operations).

3.2 Definition of Low, Moderate, High, and Extreme Categories

The detailed ranking of the shoreline and offshore areas (described in Section 2 of this appendix) was simplified to four degrees of sensitivity (LOW, MODERATE, HIGH, and EXTREME). Associated colour bands on the maps allow immediate determination of relative sensitivities in the event of an oil spill.

Distributions of all the Sensitivity Rankings were constructed to assist in defining the four degrees of sensitivity. Figure A7 shows the distribution of sensitivity rankings. The maximum ranking assigned was 55.5 for Area 12 and the minimum ranking was 9.5 for Area 25. Table A18 shows the overall ranking values for each area in descending order.

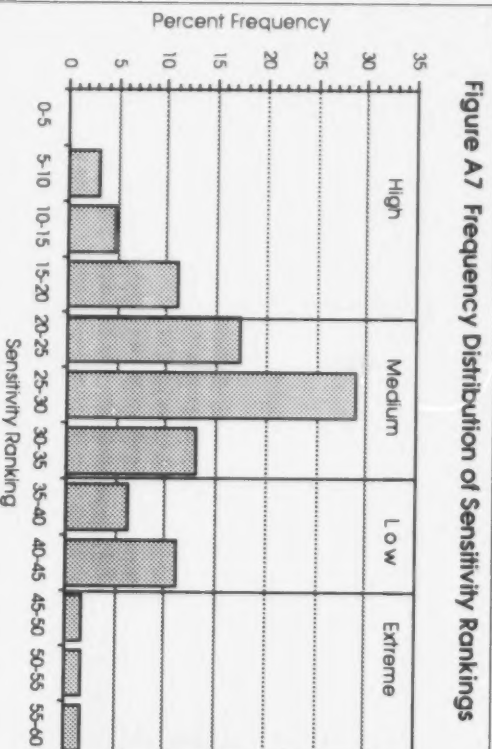


Table A18 Sensitivity Rankings by Rank

Area	Map	Sensitivity Ranking
12	3, 4	55.5
34	11	52.5
3	1	46.2
48	16	44.9
11	3	44.0
46	15, 16	43.4
9	3	42.0
13	4	41.4
59	19	41.1
22	7	40.3
14	4	39.5
8	3	37.9
4	1, 2	37.5
7	3, 4	37.2

Table A18
(continued)

Area	Map	Sensitivity Ranking
47	15, 16	34.5
63	19	33.2
50	16	33.1
51	17	32.2
49	16	31.0
42	14, 15	30.5
35	11, 12	30.3
61	19	30.3
40	13, 14	29.3
20	6	28.2
55	18	28.2
1	1	27.3
16	5	27.1
36	12	27.1
44	15	27.1
45	15	27.1
31	10, 12	26.7
62	19	26.6
58	19	26.5
2	1	26.5
15	4, 5	26.5
41	14	25.6
10	3	25.3
52	17	25.3
60	19	25.2
21	6, 7	25.1
5	2	24.4
33	11, 12	24.2
56	18	23.6
54	17, 18	23.4
38	12, 13	23.3
43	14, 15	22.9
37	12, 13	22.5
6	2, 4	22.3

Table A18
(continued)

Area	Map	Sensitivity Ranking
28	9	21.6
57	18	21.0
32	10, 12	20.2
17	5	19.6
39	13	18.8
53	17	18.6
23	7, 8	16.6
18	5, 6	16.5
27	9	16.3
19	6	16.2
30	10	12.4
26	8, 9	12.2
24	8	10.9
29	9, 10	9.8
25	8, 9	9.5

The divisions between Low, Moderate, High, and Extreme were based on a subjective appraisal of the numbers of areas falling within a certain band of sensitivities, rather than any statistical calculation. This approach yielded the following divisions:

LOW	<21
MODERATE	21 to 34.9
HIGH	35 to 45
EXTREME	>45

As discussed in the User's Guide, the detailed makeup of the ranking values is still required in order to understand which categories are making the greatest contribution to a given ranking value (Table A19).

Table A19 Breakdown of Area Sensitivity Rankings

Area	Length (km)	Location	Category	Normalized Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
1	0.564	Race Rocks	Human Use Biological Resources Special Status Areas Shoreline	4.6 9.5 0 1	2 1.75 1.5 1.5	9.2 16.6 0.0 1.5	27.3
2	8.195	Christopher Pt.-Smyth Head	Human Use Biological Resources Special Status Areas Shoreline	4.6 5.1 3.7 1.9	2 1.75 1.5 1.5	9.2 8.9 5.6 2.9	26.5
3	8.814	NE Becher Bay	Human Use Biological Resources Special Status Areas Shoreline	10 5.2 6.3 5.1	2 1.75 1.5 1.5	20.0 9.1 9.5 7.7	46.2
4	6.176	W Becher Bay	Human Use Biological Resources Special Status Areas Shoreline	6.3 4.6 7.4 3.8	2 1.75 1.5 1.5	12.6 8.1 11.1 5.7	37.5
5	9.634	Beechey Head	Human Use Biological Resources Special Status Areas Shoreline	4.9 3 5.2 1	2 1.75 1.5 1.5	9.8 5.3 7.8 1.5	24.4
6	5.154	Possession Point	Human Use Biological Resources Special Status Areas Shoreline	4.9 2 4.1 1.9	2 1.75 1.5 1.5	9.8 3.5 6.2 2.9	22.3
7	5.927	E Sooke Harbour	Human Use Biological Resources Special Status Areas Shoreline	4.2 5.3 3.3 9.7	2 1.75 1.5 1.5	8.4 9.3 5.0 14.6	37.2

Table A19
(continued)

Area	Length (km)	Location	Category	Normalized Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
8	4.253	SW Sooke Basin	Human Use Biological Resources Special Status Areas Shoreline	7 4.4 2.6 8.2	2 1.75 1.5 1.5	14.0 7.7 3.9 12.3	37.9
9	8.571	SE Sooke Basin	Human Use Biological Resources Special Status Areas Shoreline	6 6 5.9 7.1	2 1.75 1.5 1.5	12.0 10.5 8.9 10.7	42.0
10	4.782	NE Sooke Basin	Human Use Biological Resources Special Status Areas Shoreline	3 5.1 3.3 3.6	2 1.75 1.5 1.5	6.0 8.9 5.0 5.4	25.3
11	6.144	NW Sooke Basin	Human Use Biological Resources Special Status Areas Shoreline	7.8 4.8 3.3 10	2 1.75 1.5 1.5	15.6 8.4 5.0 15.0	44.0
12	2.165	Sooke River estuary	Human Use Biological Resources Special Status Areas Shoreline	9.3 10 5.9 7	2 1.75 1.5 1.5	18.6 17.5 8.9 10.5	55.5
13	5.591	Sooke Harbour	Human Use Biological Resources Special Status Areas Shoreline	7 5.2 3 9.2	2 1.75 1.5 1.5	14.0 9.1 4.5 13.8	41.4
14	6.198	Whiffin Spit to Sooke Bay	Human Use Biological Resources Special Status Areas Shoreline	8.2 5.4 2.6 6.5	2 1.75 1.5 1.5	16.4 9.5 3.9 9.8	39.5

Table A19
(continued)

Area	Length (km)	Location	Category	Normalized Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
15	4.684	Sooke Bay to Otter Point	Human Use Biological Resources Special Status Areas Shoreline	4.6 4.2 1.1 5.5	2 1.75 1.5 1.5	9.2 7.4 1.7 8.3	26.5
16	4.688	West of Otter Point	Human Use Biological Resources Special Status Areas Shoreline	4.5 3.3 1.9 6.3	2 1.75 1.5 1.5	9.0 5.8 2.9 9.5	27.1
17	4.092	Orveas Bay	Human Use Biological Resources Special Status Areas Shoreline	2.4 2.1 0 7.4	2 1.75 1.5 1.5	4.8 3.7 0.0 11.1	19.6
18	3.536	Sheringham Point	Human Use Biological Resources Special Status Areas Shoreline	2.5 1.6 3 2.8	2 1.75 1.5 1.5	5.0 2.8 4.5 4.2	16.5
19	2.737	French Beach	Human Use Biological Resources Special Status Areas Shoreline	2.5 1.7 2.2 3.3	2 1.75 1.5 1.5	5.0 3.0 3.3 5.0	16.2
20	4.925	Point-No-Point	Human Use Biological Resources Special Status Areas Shoreline	5.7 4.3 1.1 5.1	2 1.75 1.5 1.5	11.4 7.5 1.7 7.7	28.2
21	2.937	E Jordan River	Human Use Biological Resources Special Status Areas Shoreline	4.2 3.8 0.7 6	2 1.75 1.5 1.5	8.4 6.7 1.1 9.0	25.1

Table A19
(continued)

Area	Length (km)	Location	Category	Normalized Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
22	4.712	Jordan R. estuary/China Beach	Human Use Biological Resources Special Status Areas Shoreline	7.9 5.1 4.4 6	2 1.75 1.5 1.5	15.8 8.9 6.6 9.0	40.3
23	5.632	San Simon Point	Human Use Biological Resources Special Status Areas Shoreline	3.4 1.5 3 1.8	2 1.75 1.5 1.5	6.8 2.6 4.5 2.7	16.6
24	3.299	Clinch Creek	Human Use Biological Resources Special Status Areas Shoreline	2.7 1.4 0 2	2 1.75 1.5 1.5	5.4 2.5 0.0 3.0	10.9
25	3.825	Magdalena Point	Human Use Biological Resources Special Status Areas Shoreline	2.7 1.4 0 1.1	2 1.75 1.5 1.5	5.4 2.5 0.0 1.7	9.5
26	2.595	Loss Creek	Human Use Biological Resources Special Status Areas Shoreline	2.7 1.3 0 3	2 1.75 1.5 1.5	5.4 2.3 0.0 4.5	12.2
27	2.295	Sombrio Point	Human Use Biological Resources Special Status Areas Shoreline	4.6 3.2 0 1	2 1.75 1.5 1.5	9.2 5.6 0.0 1.5	16.3
28	2.441	Sombrio Beach	Human Use Biological Resources Special Status Areas Shoreline	3.7 2 3 4.1	2 1.75 1.5 1.5	7.4 3.5 4.5 6.2	21.6

Table A19
(continued)

Area	Length (km)	Location	Category	Normalized Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
29	4.719	Kuitshe Creek	Human Use Biological Resources Special Status Areas Shoreline	3 1.3 0 1	2 1.75 1.5 1.5	6.0 2.3 0.0 1.5	9.8
30	4.482	Providence Cove	Human Use Biological Resources Special Status Areas Shoreline	3 2.2 0 1.7	2 1.75 1.5 1.5	6.0 3.9 0.0 2.6	12.4
31	4.490	Botanical Beach	Human Use Biological Resources Special Status Areas Shoreline	5.2 4.4 4.4 1.3	2 1.75 1.5 1.5	10.4 7.7 6.6 2.0	26.7
32	2.526	E Port San Juan	Human Use Biological Resources Special Status Areas Shoreline	4.2 4 2.2 1	2 1.75 1.5 1.5	8.4 7.0 3.3 1.5	20.2
33	3.628	E Port San Juan	Human Use Biological Resources Special Status Areas Shoreline	7.3 3.7 0 2.1	2 1.75 1.5 1.5	14.6 6.5 0.0 3.2	24.2
34	5.511	Gordon/San Juan Rivers	Human Use Biological Resources Special Status Areas Shoreline	8.1 7.1 7.8 8.1	2 1.75 1.5 1.5	16.2 12.4 11.7 12.2	52.5
35	2.738	W Port San Juan	Human Use Biological Resources Special Status Areas Shoreline	3 3.6 7 5	2 1.75 1.5 1.5	6.0 6.3 10.5 7.5	30.3

Table A19
(continued)

Area	Length (km)	Location	Category	Normalized Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
36	5.181	W Port San Juan	Human Use Biological Resources Special Status Areas Shoreline	4.8 4.4 4.4 2.1	2 1.75 1.5 1.5	9.6 7.7 6.6 3.2	27.1
37	5.939	Owen Point	Human Use Biological Resources Special Status Areas Shoreline	4.9 1.7 3.7 2.8	2 1.75 1.5 1.5	9.8 3.0 5.6 4.2	22.5
38	5.156	Cullite Cove	Human Use Biological Resources Special Status Areas Shoreline	3.6 3.2 4.4 2.6	2 1.75 1.5 1.5	7.2 5.6 6.6 3.9	23.3
39	4.207	Logan Creek	Human Use Biological Resources Special Status Areas Shoreline	3.6 1.2 3.7 2.6	2 1.75 1.5 1.5	7.2 2.1 5.6 3.9	18.8
40	4.520	Walbran Creek	Human Use Biological Resources Special Status Areas Shoreline	4.5 2 7 4.2	2 1.75 1.5 1.5	9.0 3.5 10.5 6.3	29.3
41	3.223	Bonilla Point	Human Use Biological Resources Special Status Areas Shoreline	4.6 2.6 5.9 2	2 1.75 1.5 1.5	9.2 4.6 8.9 3.0	25.6
42	3.752	Carmanah Creek	Human Use Biological Resources Special Status Areas Shoreline	4.5 2.5 7.4 4	2 1.75 1.5 1.5	9.0 4.4 11.1 6.0	30.5

Table A19
(continued)

Area	Length (km)	Location	Category	Normalized Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
43	2.114	Carranah Point	Human Use Biological Resources Special Status Areas Shoreline	4.6 3.8 3.7 1	2 1.75 1.5 1.5	9.2 6.7 5.6 1.5	22.9
44	1.761	Coal Creek	Human Use Biological Resources Special Status Areas Shoreline	4.5 2.8 4.8 4	2 1.75 1.5 1.5	9.0 4.9 7.2 6.0	27.1
45	3.770	E of Dare Point	Human Use Biological Resources Special Status Areas Shoreline	3.9 3.5 7 1.8	2 1.75 1.5 1.5	7.8 6.1 10.5 2.7	27.1
46	3.577	Cheewah River estuary	Human Use Biological Resources Special Status Areas Shoreline	5.2 4.9 8.9 7.4	2 1.75 1.5 1.5	10.4 8.6 13.4 11.1	43.4
47	3.200	Stanley Beach	Human Use Biological Resources Special Status Areas Shoreline	4.9 3.3 9.6 3	2 1.75 1.5 1.5	9.8 5.8 14.4 4.5	34.5
48	7.473	Nitinah Narrows	Human Use Biological Resources Special Status Areas Shoreline	6 6.3 10 4.6	2 1.75 1.5 1.5	12.0 11.0 15.0 6.9	44.9
49	3.876	Tsuquanah Point	Human Use Biological Resources Special Status Areas Shoreline	4.5 3.2 8.1 2.8	2 1.75 1.5 1.5	9.0 5.6 12.2 4.2	31.0

Table A19
(continued)

Area	Length (km)	Location	Category	Normalized Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
50	2.635	E of Tusiat Point	Human Use Biological Resources Special Status Areas Shoreline	4.8 4.4 7 3.5	2 1.75 1.5 1.5	9.6 7.7 10.5 5.3	33.1
51	4.933	W of Tusiat Point	Human Use Biological Resources Special Status Areas Shoreline	4.8 4.1 5.6 4.7	2 1.75 1.5 1.5	9.6 7.2 8.4 7.1	32.2
52	2.898	W of Klanawa River	Human Use Biological Resources Special Status Areas Shoreline	4.2 3.5 5.2 2	2 1.75 1.5 1.5	8.4 6.1 7.8 3.0	25.3
53	2.173	W of Klanawa River	Human Use Biological Resources Special Status Areas Shoreline	2.7 3.5 3.7 1	2 1.75 1.5 1.5	5.4 6.1 5.6 1.5	18.6
54	6.310	E of Pachena Point	Human Use Biological Resources Special Status Areas Shoreline	3.4 3.8 4.1 2.5	2 1.75 1.5 1.5	6.8 6.7 6.2 3.8	23.4
55	4.491	Pachena Point	Human Use Biological Resources Special Status Areas Shoreline	4.9 4.5 5.9 1.1	2 1.75 1.5 1.5	9.8 7.9 8.9 1.7	28.2
56	3.950	Masit Reserve	Human Use Biological Resources Special Status Areas Shoreline	3.3 2.5 6.7 1.7	2 1.75 1.5 1.5	6.6 4.4 10.1 2.6	23.6

Table A19
(continued)

Area	Length (km)	Location	Category	Normalized Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
57	0.397	Seabird Rocks	Human Use Biological Resources Special Status Areas Shoreline	3.3 4.2 3.7 1	2 1.75 1.5 1.5	6.6 7.4 5.6 1.5	21.0
58	5.917	E Pachena Bay	Human Use Biological Resources Special Status Areas Shoreline	4.2 5.3 4.1 1.8	2 1.75 1.5 1.5	8.4 9.3 6.2 2.7	26.5
59	4.668	Pachena River estuary	Human Use Biological Resources Special Status Areas Shoreline	6.3 4.7 5.9 7.6	2 1.75 1.5 1.5	12.6 8.2 8.9 11.4	41.1
60	3.177	W Pachena Bay	Human Use Biological Resources Special Status Areas Shoreline	3.9 3 5.9 2.2	2 1.75 1.5 1.5	7.8 5.3 8.9 3.3	25.2
61	3.957	Clurus Point	Human Use Biological Resources Special Status Areas Shoreline	4.5 3.4 7.8 2.4	2 1.75 1.5 1.5	9.0 6.0 11.7 3.6	30.3
62	1.976	Keeha Bay	Human Use Biological Resources Special Status Areas Shoreline	2.4 2.7 7 4.4	2 1.75 1.5 1.5	4.8 4.7 10.5 6.6	26.6
63	7.519	Cape Beale	Human Use Biological Resources Special Status Areas Shoreline	3.7 5.3 7.4 3.6	2 1.75 1.5 1.5	7.4 9.3 11.1 5.4	33.2

CLIMATE AND OCEANOGRAPHY

1.0 INTRODUCTION

This Appendix describes the oceanography and climate of the southwest coast of Vancouver Island. The information presented was selected on the basis of its relevance to oil spill countermeasures response.

The Appendix consists of four sections: tides, tidal currents, residual currents, and physical environment for countermeasures. Tidal and residual currents are presented in Maps B-1 to B-5. The physical environment section presents wind, wave, visibility, sea temperature, and air temperature data graphically through line plots and histograms.

2.0 TIDES

Tides along the southwest coast of Vancouver Island are classified as mixed diurnal and semidiurnal. At Cape Beale the semidiurnal tide dominates the mixed tide. The result is two daily high waters of unequal height and two low waters of greater inequality, as shown in Figure B1. As one moves east towards Race Rocks the tides remain mixed, but the diurnal tides dominate. The diurnal tide increases the inequality of the low waters so that during some periods of the month there is only one daily cycle, as shown in Figure B2.

The tidal range (difference between higher high water and lower low water) increases as one moves east in the Strait (Map B-1). The tidal range for a large tide is given for several locations in Map B-1.

Figure B1 Tides at Sooke

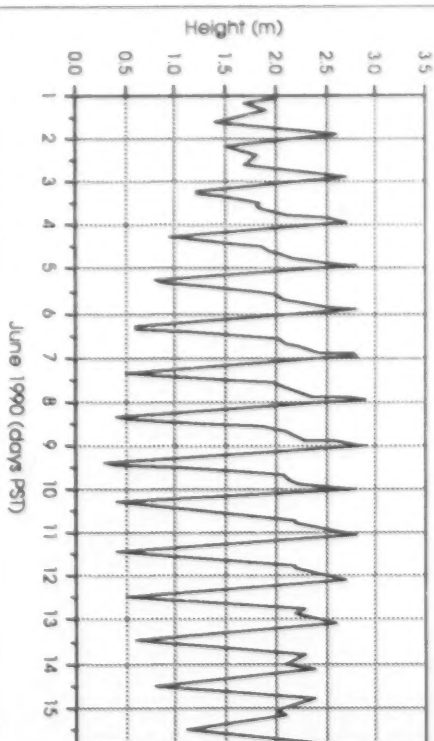
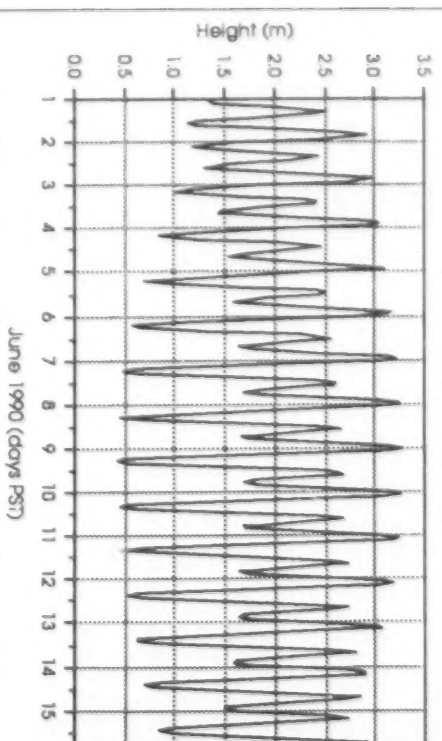
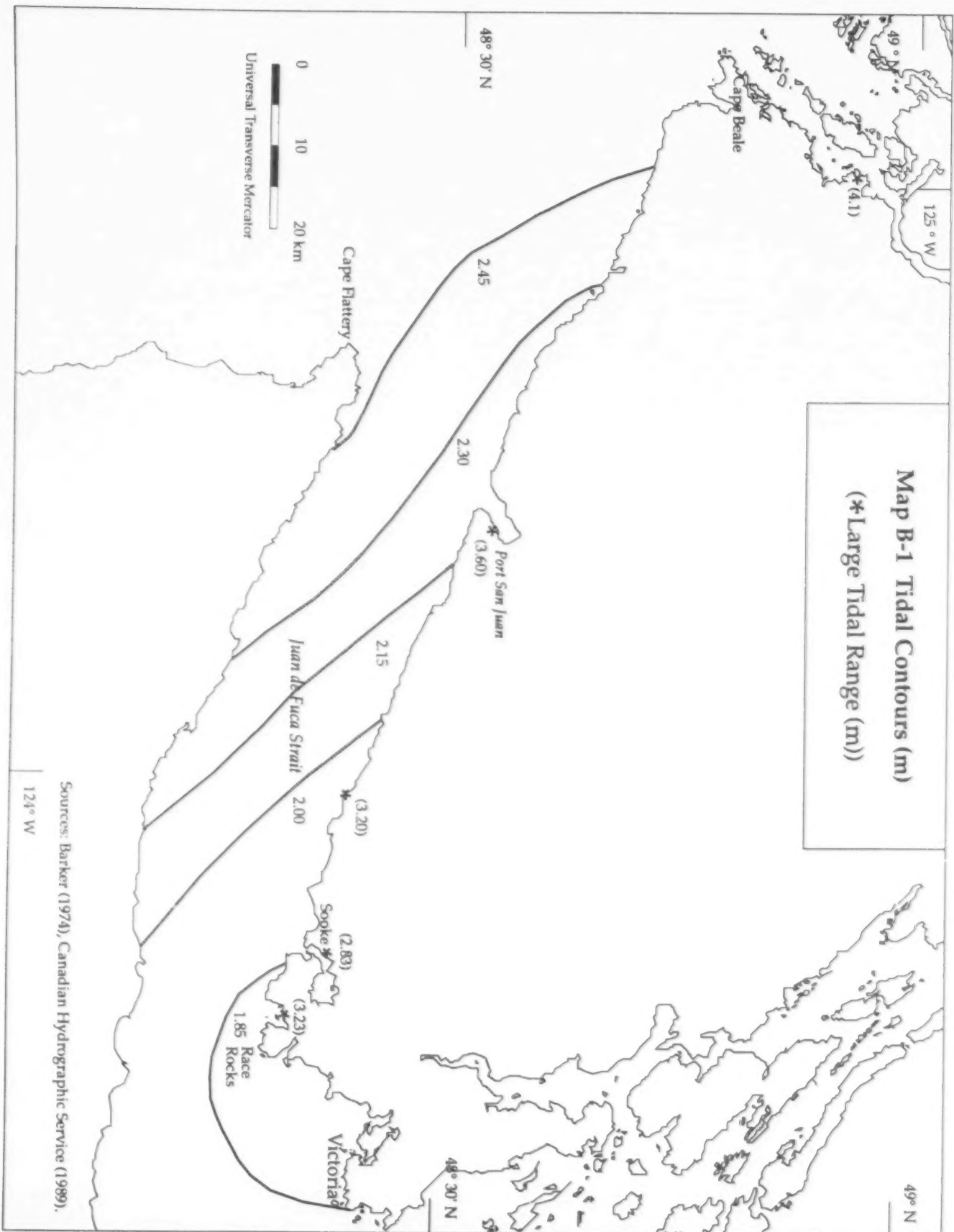


Figure B2 Tides at Cape Beale
(from tides at Bamfield)



Map B-1 Tidal Contours (m) (* Large Tidal Range (m))



Sources: Barker (1974), Canadian Hydrographic Service (1989).

3.0 TIDAL CURRENTS

Maps B-2 to B-5 show the surface tidal currents for the study area for the tidal cycle of December 31, 1987 to January 1, 1988. This cycle is representative of a mean tide. Current features finer than 3 km in scale are not presented.

The tidal currents in the Juan de Fuca Strait are relatively simple. The ebb and flood currents are generally parallel to the shore and opposite in direction. In fact the change from ebb to flood is nearly linear (Thomson, 1981). The ebb current (carried by the surface water layers) is stronger and more persistent than the flood currents (carried by the deeper water layers). The flood current is also weaker on the Canadian side of the Strait (Thomson, 1981).

The currents lag behind the tides at the entrance to Juan de Fuca Strait. As a result maximum flood and ebb currents occur 1.0-1.5 hours after high and low waters. This lag decreases eastwards in the Strait until at Race Rocks the currents and tides are almost in phase (Thomson, 1981).

Several current eddies are created during slack tides. Map B-3 shows a portion of the Swiftsure Bank eddy moving clockwise at the start of the flood stream. During the transition from flood to ebb the Swiftsure bank eddy turns counterclockwise as shown in Map B-5. Another eddy occurs in the vicinity of Race Rocks, with associated currents in excess of 2.5 kts.

There is a significant difference between the currents for a spring or maximum tide and those for a minimum or neap tide. Table B1 compares the ebb and flood currents for mid-Juan de Fuca Strait during a maximum, mean, and minimum tide.

Note: where currents are less than 0.75 knots and waves are less than 1 m, it may be possible to contain oil with stationary booms. Above this current speed, oil will be swept under stationary booms.

The four tidal current maps (Maps B-2 to B-5) were compiled from two numerical tidal current models. Currents from Sheringham Point east are from the Canadian Hydrographic Service (1987). Currents from Point No Point to Cape Beale were obtained from a barotropic tidal model of

southwest Vancouver Island (Foreman, 1990).

Table B1 Range of Tidal Currents
(Canadian Hydrographic Service, 1990)

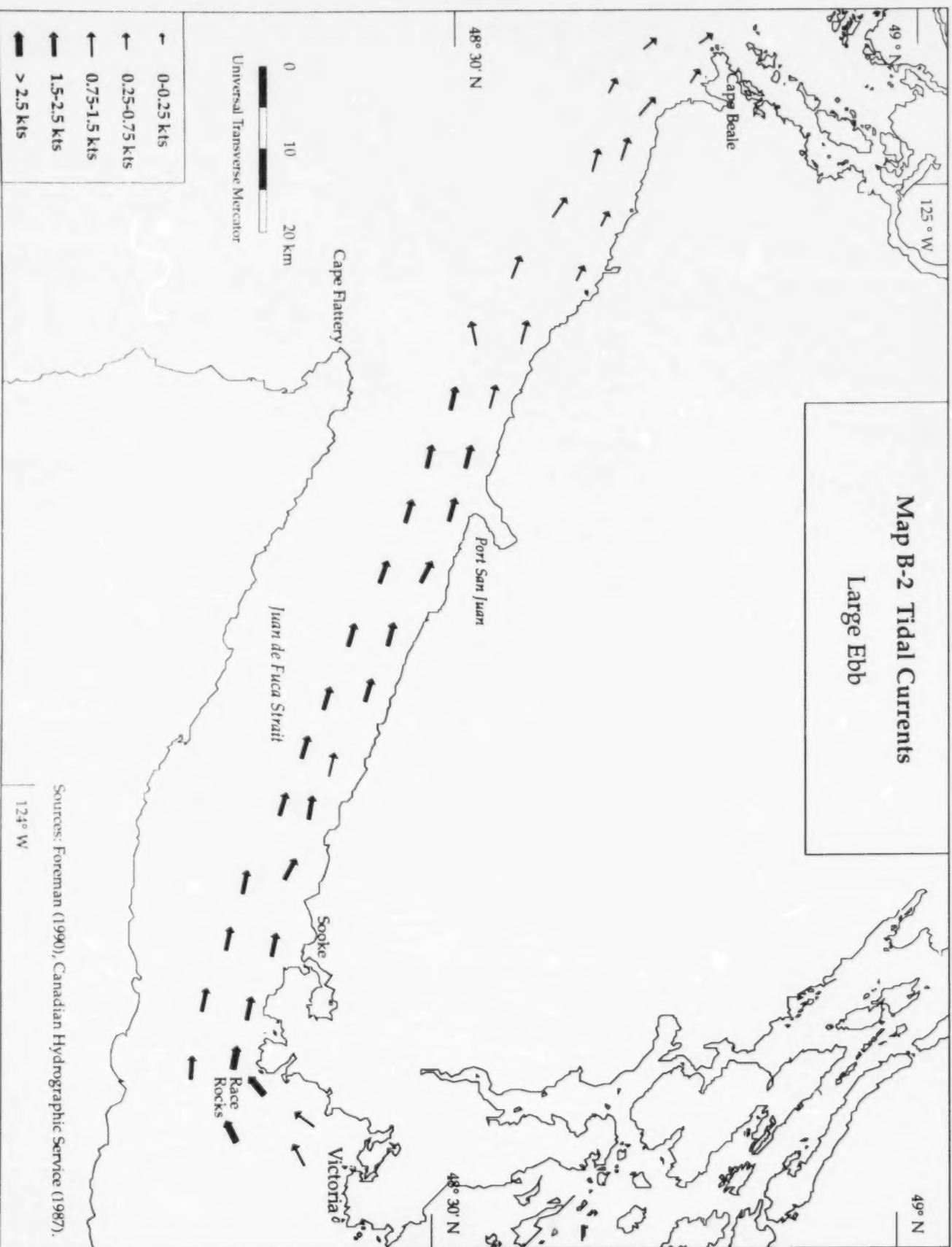
	Maximum Tide (Spring Tide)	Mean Tide	Minimum Tide (Neap Tide)
Flood (kts)	1.6	1.0	0.5
Ebb (kts)	2.4	2.0	1.4

Measurements of surface tidal currents in Juan de Fuca Strait are sparse (the heavy use of the Strait limits the use of moored current meters). Although the numerical models used the available measurements for calibration, the results are useful as a guide only since the accuracy in many locations is unknown. Eddies predicted by the models may or may not exist. Foreman's model (1990) and the Canadian Hydrographic Survey (1987) assume uniform water density, absence of vertical current components, and uniform horizontal currents throughout the water column. These assumptions may cause inaccuracies of up to 30% (M. Foreman, pers. comm.). To compensate for inaccuracies, the currents in Maps B-2 to B-5 have been grouped into five categories. The range of current values in each category is at least 40% of the maximum value of the category.

The numerical models do not account for the influence of the residual (non-tidal) currents on the tidal currents (see Map B-6), which at times can be significant.

The numerical tidal currents provide a simplified indication of the nearshore (within 1-2 km) flow; the grid spacing of the models (2-4 km) is not fine enough to predict bottom effects and shadowing by land. For example the models do not predict back eddies during ebbing near Otter Point although such eddies have been observed (Thomson, 1981). Tidal currents nearshore tend to be weaker and flood and ebb one-half hour earlier than offshore currents (Thomson, 1981).

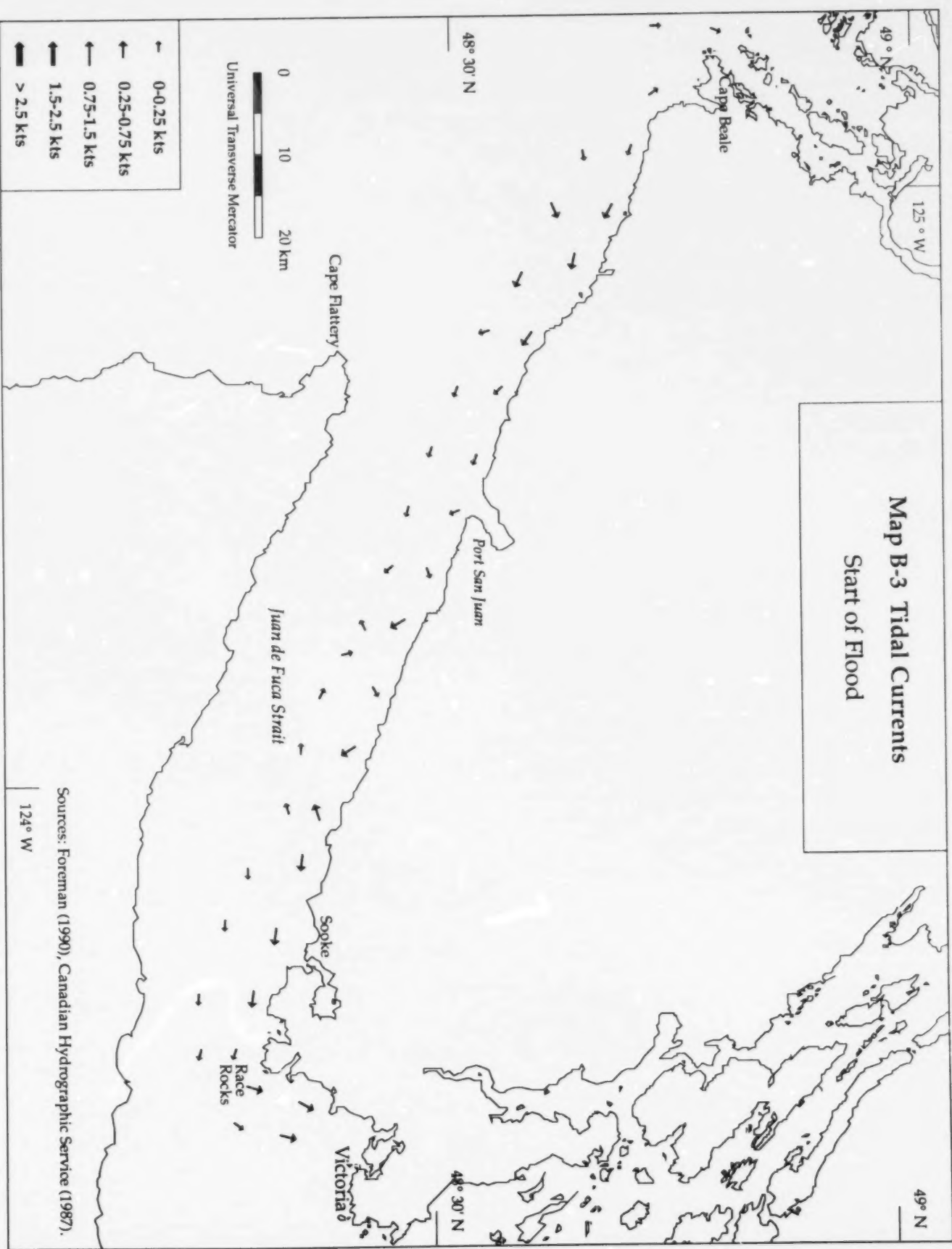
Map B-2 Tidal Currents Large Ebb



Sources: Foreman (1990), Canadian Hydrographic Service (1987).

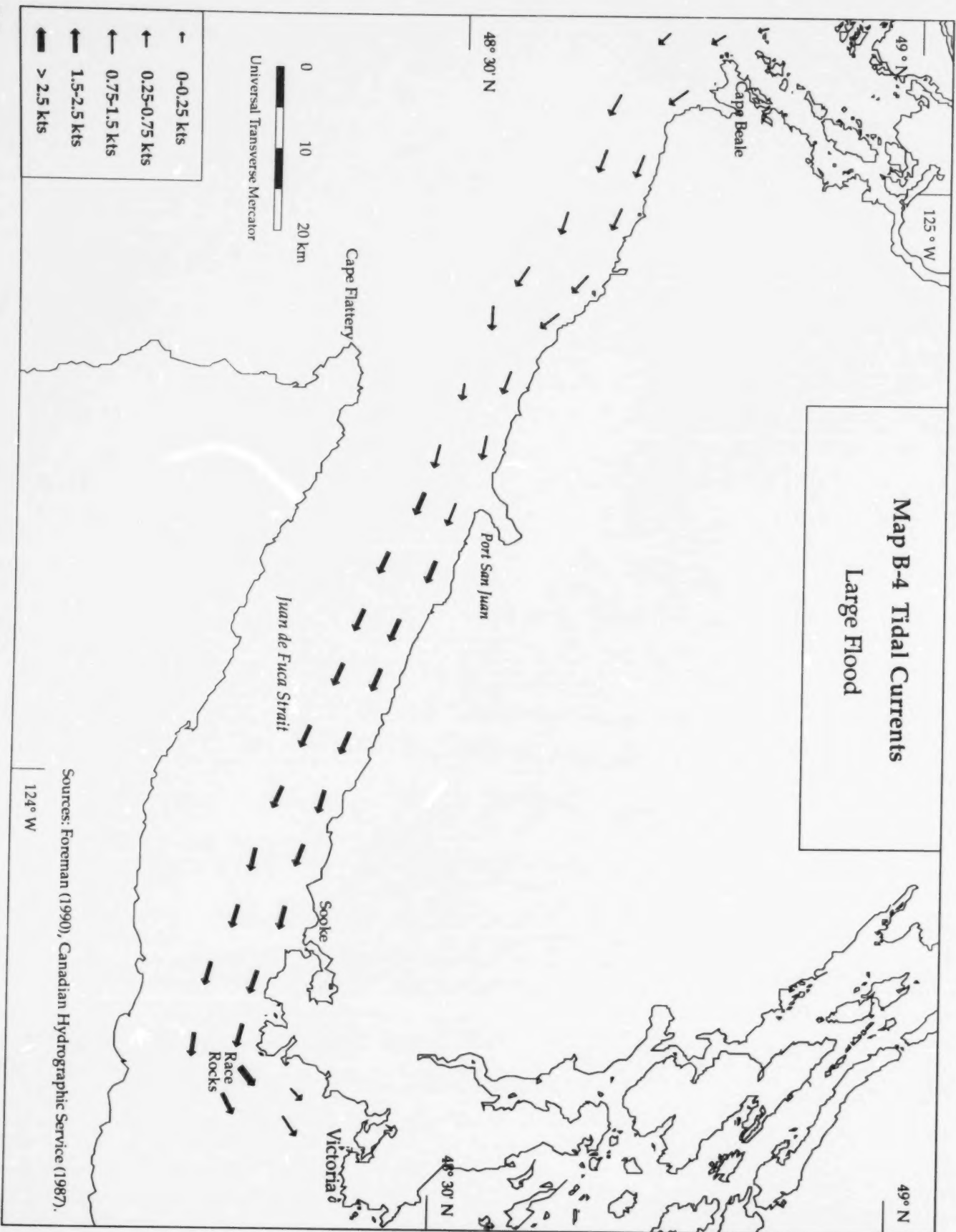
124° W

Map B-3 Tidal Currents Start of Flood



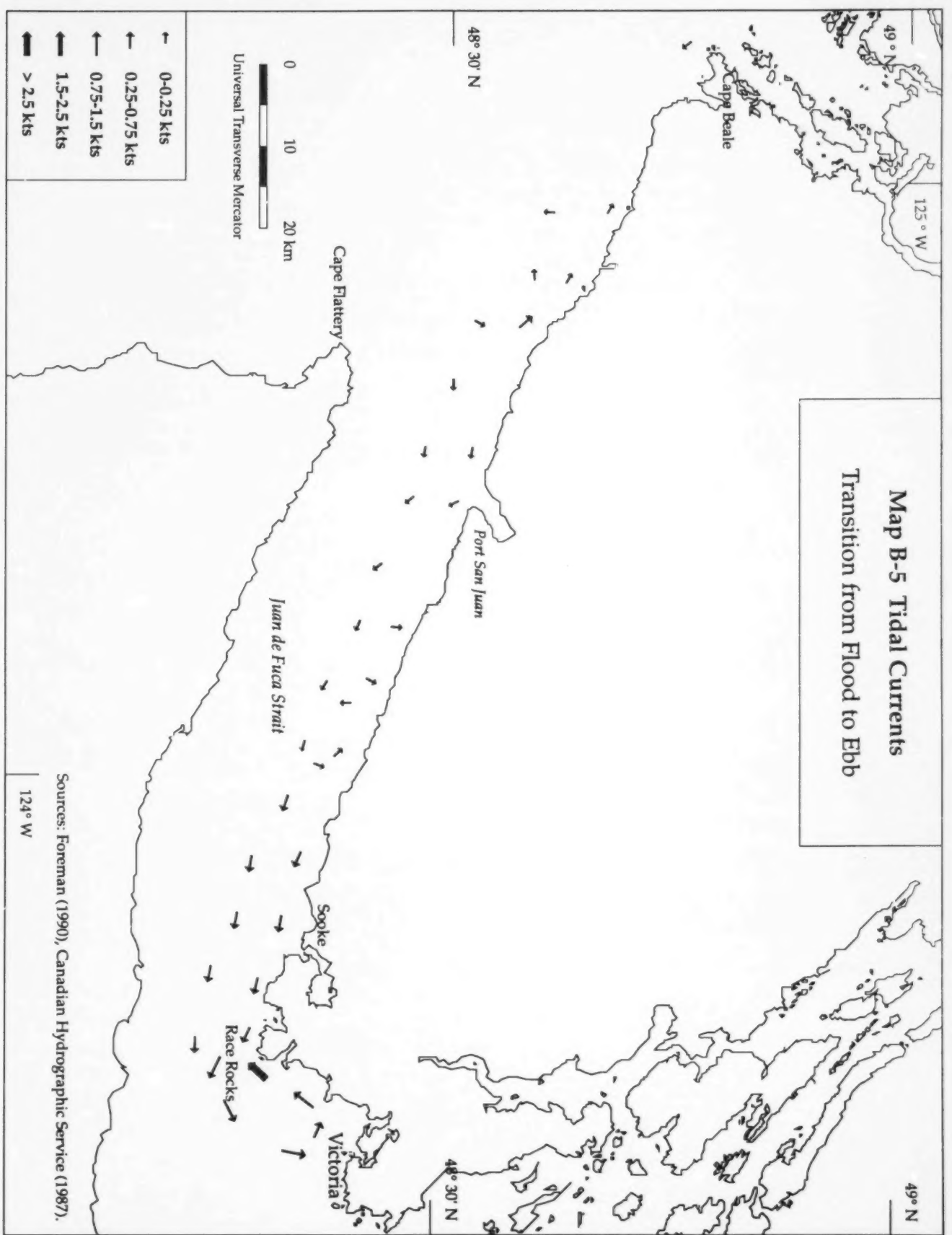
Sources: Foreman (1990), Canadian Hydrographic Service (1987).

Map B-4 Tidal Currents Large Flood



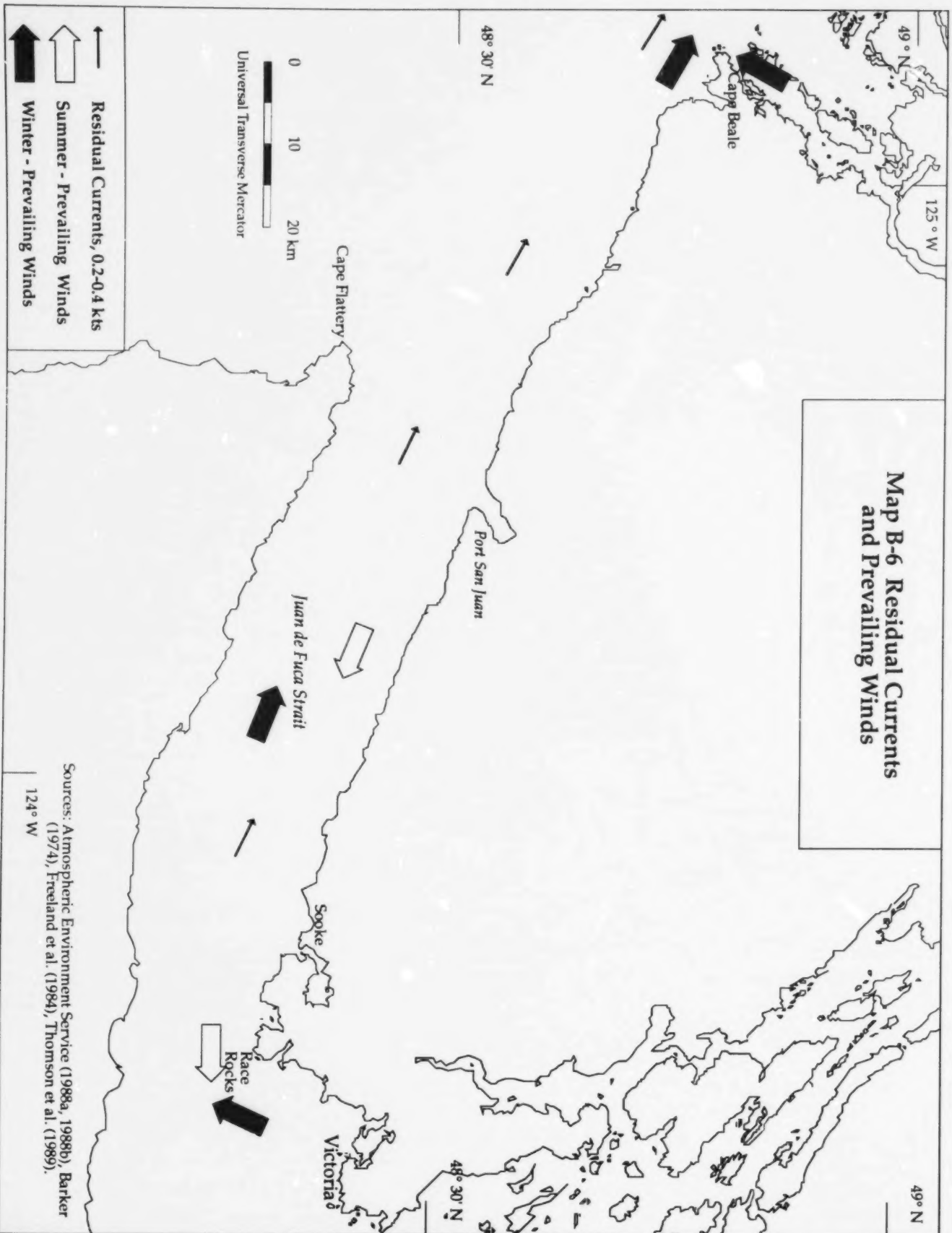
Sources: Foreman (1990), Canadian Hydrographic Service (1987).

Map B-5 Tidal Currents Transition from Flood to Ebb



Sources: Foreman (1990), Canadian Hydrographic Service (1987).

Map B-6 Residual Currents
and Prevailing Winds



4.0 RESIDUAL CURRENTS

In addition to the tidal currents, a residual (non-tidal) current flows northwest along the coast of southwestern Vancouver Island. West of the Pacific entrance to Juan de Fuca Strait, this current has been labeled the Vancouver Island Coastal Current. The residual current stream averages 0.2-0.4 knots and occupies the inner continental shelf (Thomson et al., 1989; Thomson, 1981). The residual currents are responsible for long-term drift.

Estuarine flow contributes significantly to the current. The coastal runoff from precipitation-fed streams on Vancouver Island contributes to the current during the fall and winter when rainfall is maximum. The other major source of fresh water in the coastal current is the Fraser and Squamish River freshets. The freshets (melt-water from the interior snow pack) peak during the early summer causing currents of up to 0.8 knots in Juan de Fuca Strait (Thomson, 1981).

In the summer, the prevailing northwest winds blow counter to the coastal current, slowing the speed of the current at the surface. Prevailing winds in excess of 20 knots can reverse the direction of the surface currents (Thomson et al., 1989).

During the early winter, the residual current frequently changes direction and flows east, up the Strait. Low Fraser River discharge and southerly winds in Haro Strait are responsible for these changes (Thomson, 1981). The current has also been observed to stall for several days at a time during any season (Thomson, 1981). The prevailing winds and the current along southwestern Vancouver Island move in the same general direction during the winter.

Measured residual currents at 50 m depth, 10 km southwest of Cape Beale, averaged 0.25 knots during the fall and winter (Freeland et al., 1984). At the same location in the summer, the average current most months was 0.13 knots, and during several summer months the average current was negligible.

5.0 PHYSICAL ENVIRONMENT DATA FOR COUNTERMEASURES

This Section graphically presents wind, wave, visibility, sea temperature, and air temperature data for use in countermeasures planning. The parameters presented were selected on the basis of their relevance to oil spill countermeasures response as described below.

Wind speed and direction affect surface water movements and hence oil slick movement as well as determining probable positions for deflection booming (Figures B3 to B10).

Wind speeds ≥ 17 knots will begin to limit the use of containment booming, aerial igniters, aerial dispersant application, and contained burning of oil (Figures B11 and B12).

The persistence of wind speeds ≥ 17 knots and winds ≥ 34 knots indicates the probability of high winds (unfavourable to cleanup operations) lasting for a specified time (Figure B13 and B14).

The frequency of marine visibility affects marine operations for surveillance and cleanup activities (Figure B15).

The physical properties of the oil, such as viscosity, will depend on the oil temperature which is usually taken as the sea surface temperature (Figure B16).

Wave heights greater than 1 m (Figure B17) increasingly limit the effectiveness of containment booming. Durations of wave heights unfavourable to cleanup activities indicates the length of time that activities may be suspended (Figure B18).

Weather preventing visual flight rules (VFR) flying will limit the time available for aircraft operations such as travel, surveillance, and aerial photography (Figure B19).

Air temperature will affect the performance of people and equipment as well as determining the oil properties (Figure B20).

5.1 Data Sources

A variety of existing sources were used to provide the data. The most appropriate source was selected from an oil spill response perspective using nearshore or shoreline conditions as the criteria.

Statistics for wind speed and direction were available from three sources: shore stations such as Tofino Airport, lighthouse stations, and marine area observations. The statistics for Race Rock and Cape Beale Lighthouses were chosen as being the most representative of nearshore winds (derived from Atmospheric Environment Service (AES) summaries (1988a, 1988b)). While the nearby land will alter the wind speed and direction from the offshore condition, the lighthouse setting represents the minimum disturbance possible from a land-based station.

Marine visibility, wave height frequencies, and sea surface temperatures were obtained from summaries of ship observations in the Juan de Fuca Marine Area (Brown et al., 1986). The Juan de Fuca Marine Area is the Canadian portion of the Strait from Victoria to Carmanah Point—a strip along the Vancouver Island coast roughly 10 km wide. Data for marine areas is collected from all available ship reports within the defined area.

Duration statistics can only be generated from stations or grid points which gather continuous data records. The wind and wave duration statistics presented in Figures B13, B14 and B18 were obtained from a numerical grid point analysis reported in Brower et al. (1988). The data was generated by the National Climatic Data Center of the National Oceanic and Atmospheric Administration using 12.5 years of hindcast data. The data for the nearest grid point to the study area, 49° N, 128° 24' W (approximately 300 km to the west northwest), was used.

The nearest AES weather station recording air temperatures is Tofino Airport. Air temperatures are collected during ship observations, but the AES station data is of higher quality with many more observations. Visual flight rules (VFR) flying weather (visibility greater than 4 km and ceiling greater than 300 m) is derived from Tofino Airport statistics.

The years of record and number of observations collected for each data source is presented in Table B2.

Table B2
Climatic Data Sources

Station	Parameter	Years of Record	Average Monthly Observations
Cape Beale	Wind speed and direction	1969-1986	12,485
Race Rocks	Wind speed and direction	1970-1987	13,115
Juan de Fuca Strait	Wave height Visibility Sea surface temperature	1857-1985 1857-1985 1857-1985	240 426 1,525
Tofino Airport	Air temperature Visual flight rules	1960-1985 1960-1985	17,136 17,190
49°N, 128°24'W	Wind speed durations Wave height durations	12.5 12.5	

5.2 Data Limitations

Marine data tends to be biased towards good weather. Vessels tend to avoid or move out of areas of bad weather. This bias has been compensated for by using grid point data for wind speed durations. The grid point data is prepared from an analytical model which is not affected by good or poor weather.

The wave height durations are based on the assumption that the wind had unlimited fetch for wave generation. Inside the Pacific entrance to Juan de Fuca Strait, the fetch becomes increasingly restricted. Consequently, Figure B18 presents a conservative estimate of the wave height durations for areas inside the Strait.

Figure B3 Wind Directions
January - Race Rocks

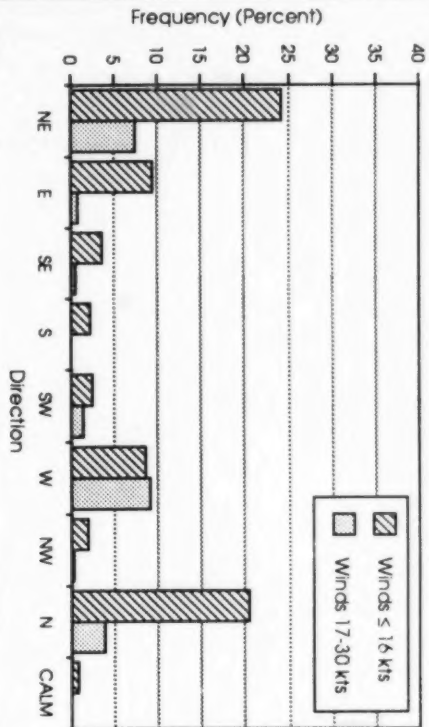


Figure B4 Wind Directions
April - Race Rocks

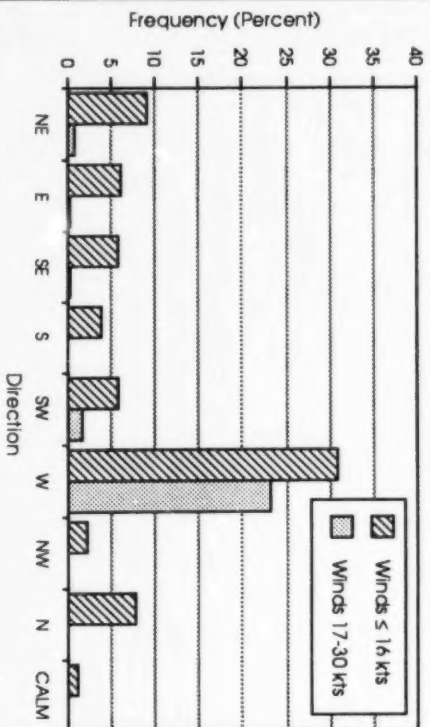


Figure B5 Wind Directions
July - Race Rocks

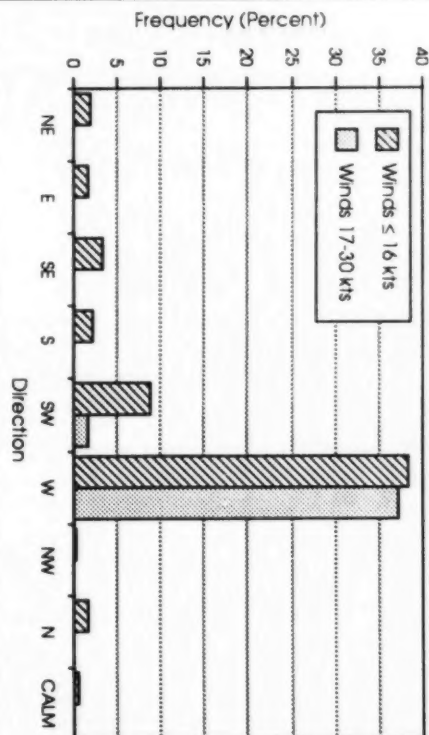


Figure B6 Wind Directions
October - Race Rocks

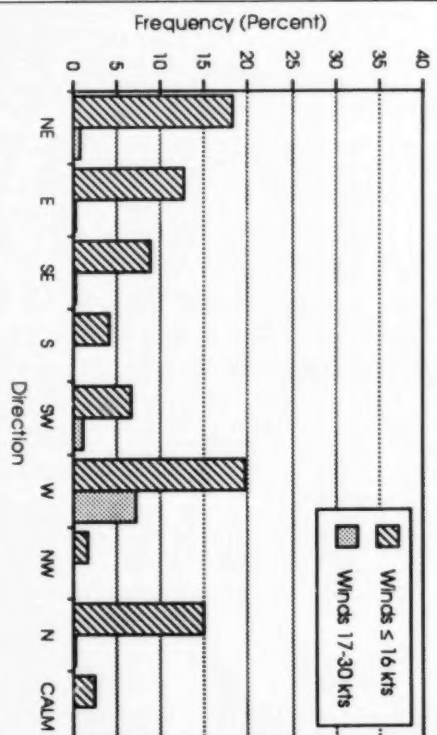


Figure B5 Wind Directions
January - Cape Beale

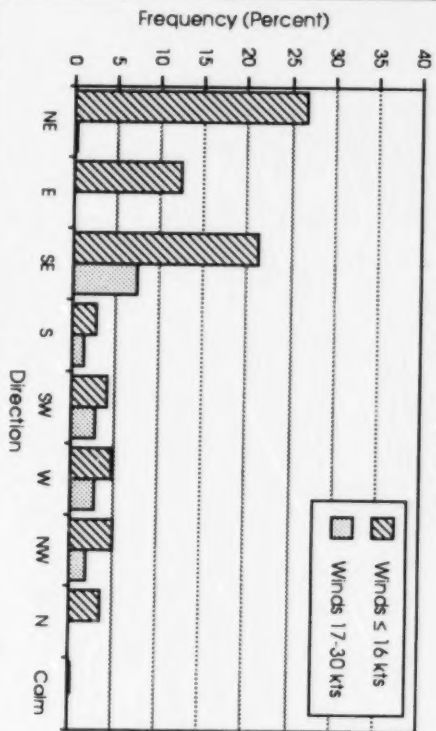


Figure B6 Wind Directions
April - Cape Beale

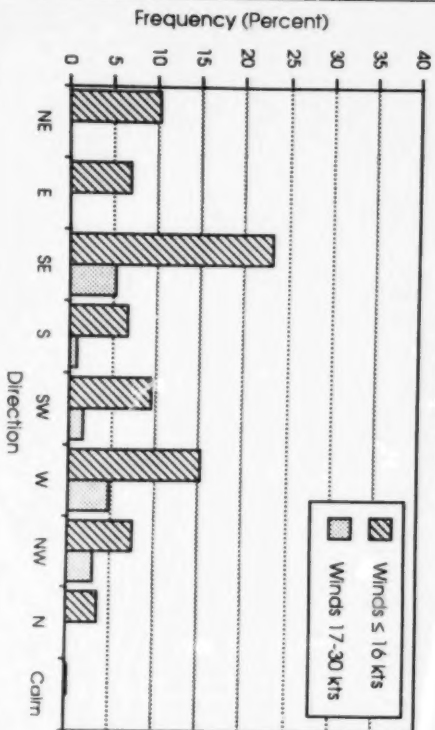


Figure B7 Wind Directions
July - Cape Beale

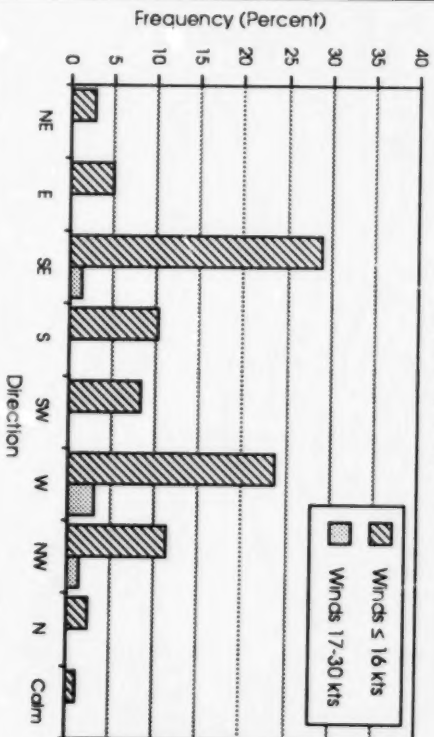


Figure B8 Wind Directions
October - Cape Beale

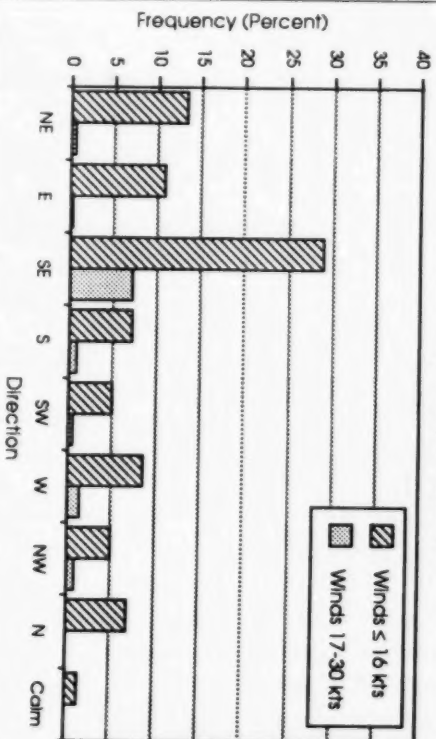


Figure B9 Wind Speeds
Race Rocks

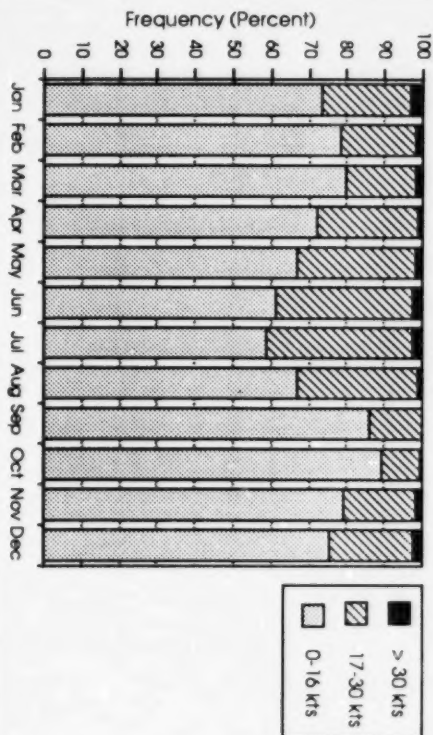


Figure B10 Wind Speeds
Cape Beale

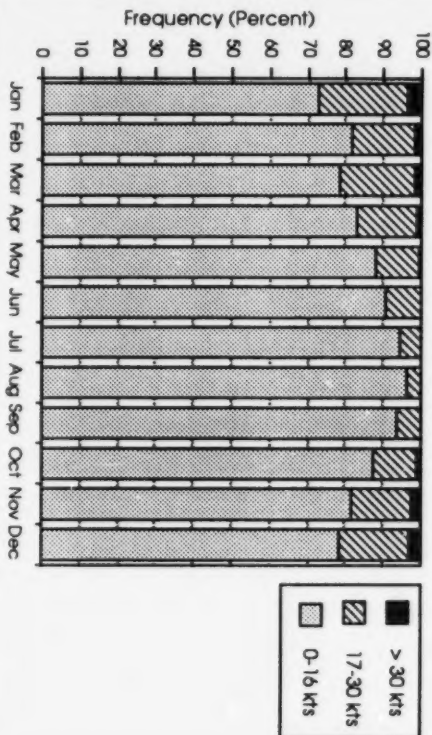


Figure B11 Wind Duration
Winter - 49° N, 128.4° W

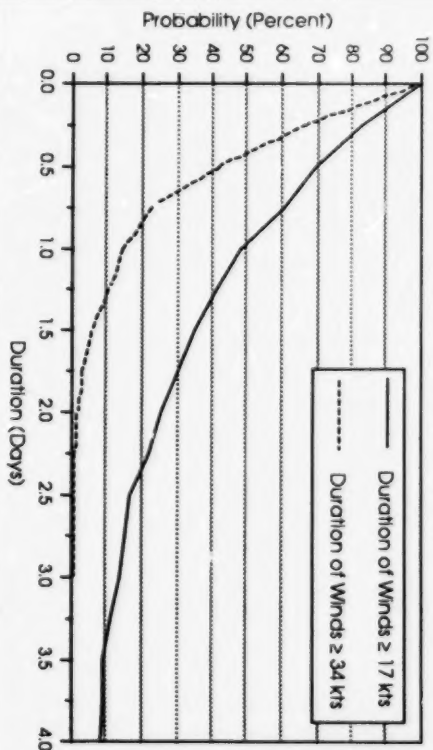


Figure B12 Wind Duration
Summer - 49° N, 128.4° W

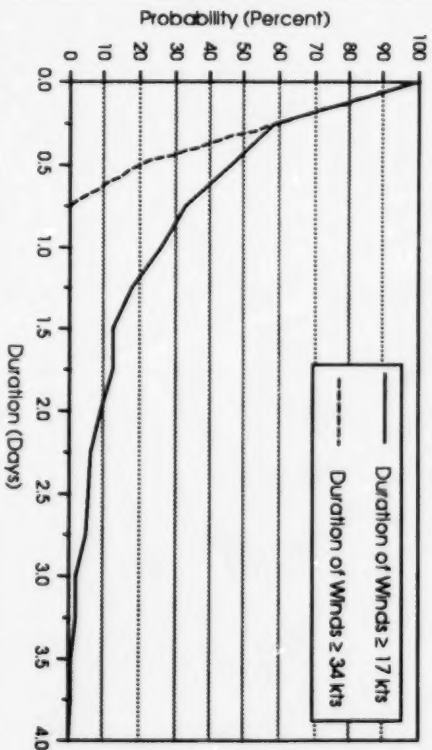


Figure B13 Visibility
Juan de Fuca Strait

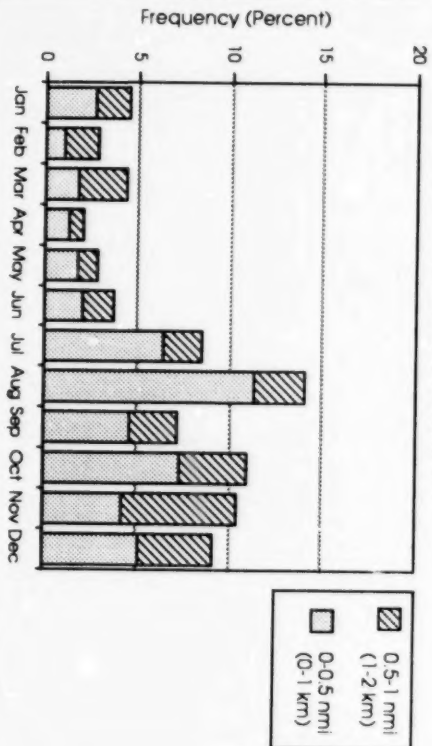


Figure B15 Wave Height Frequencies
Juan de Fuca Strait

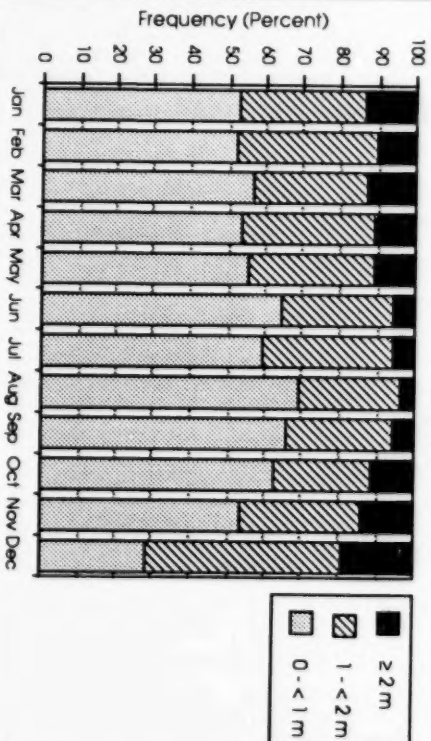


Figure B14 Sea Surface Temperature
Juan de Fuca Strait

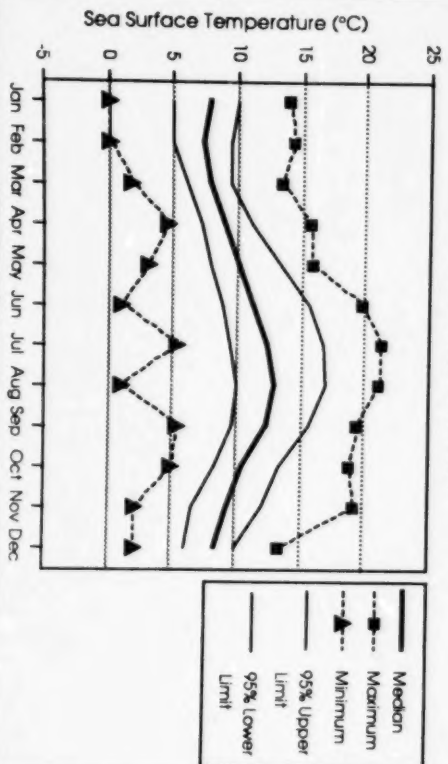


Figure B16 Wave Height Durations
49°N, 128.4°W

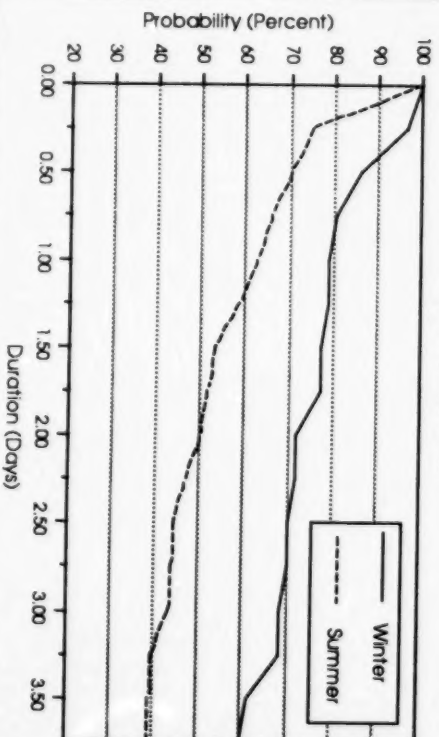


Figure B17 Frequency of Restricted Visual Flight Rules (VFR)
Tofino Airport

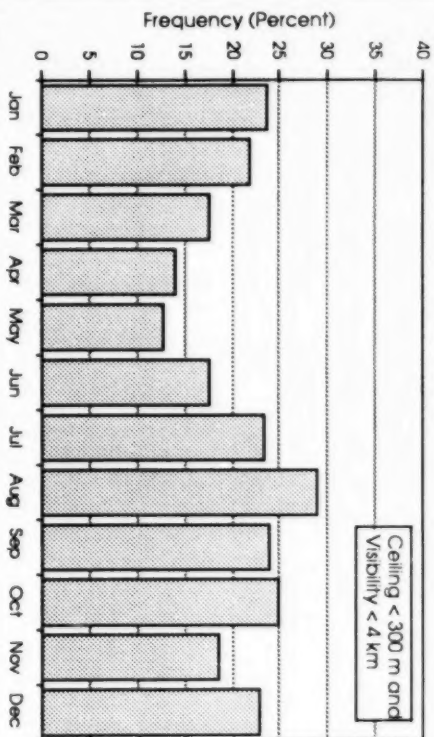


Figure B18 Air Temperature
Tofino Airport

